Risk Assessment

Mediterranean Fruit Fly

Planning and Risk Analysis Systems
Policy and Program Development
APHIS, USDA

Primary Assessor - Charles E. Miller, PRAS

Other contributions by PRAS personnel

- Lorene Chang - Technical information retrieval, Reference Section, immigration trends and passenger movement from Hawaii
- Victor Beal, Jr. and Rob McDowell - The Analysis Section
- Kathy Ortman and Teresa LaCovey - Document preparation

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ABBREVIATIONS

APHIS	Animal and Plant Health Inspection Service (of USDA)
AQI	Agriculture Quarantine Inspection (of PPQ, APHIS, USDA)
ARS	Argicultural Research Service (of USDA)
BATS	Biological Assessment and Taxonomic Support (of PPQ, APHIS, USDA)
CA	California
CDFA	California Department of Food and Agriculture
CO	County
DPI	Division of Plant Industries (of State of Florida)
FL	Florida
FY	Fiscal Year
GA	Georgia
GNP	Gross National Product
HI	Hawaii
IS	International Services (of APHIS, USDA)
JFK	John F. Kennedy International Airport
LA	Los Angeles, California
MD	Maryland
MX	Mexico
NY	New York
NJ	New Jersey
PPD	Policy and Program Development (of APHIS, USDA)
PPQ	Plant Protection and Quarantine (of APHIS, USDA)
PRAS	Planning and Risk Analysis Systems (of PPD, APHIS, USDA)
TX	Texas
USDA	United States Department of Agriculture
VS	Veterinary Services (of APHIS, USDA)
WI	Wisconsin

EXECUTIVE SUMMARY

Mediterranean fruit fly (Medfly) is one of the most serious exotic plant pests threatening U.S. agriculture. The average cost of infestations to USDA and industry can be estimated at $33 million dollars per year, but if not eradicated, the cost to live with this pest is estimated at $821 million or more per year. The major purpose of the assessment was to identify high risk pathways. It also discusses potential U.S. distribution and economic impact, and identifies potential operational changes and research needs for reducing risks.

A review of past infestations clearly show how certain areas in the United States, southern California, and southern Florida have been extremely vulnerable to Medfly introductions. Current trends in travel, immigration, and port activities indicate the same areas will be just as much at risk or more so in the future. The assessment strongly suggests that certain pathways through a relatively few ports are probably responsible for the majority of the modern introductions of Medfly and other serious fruit fly pests. The highest risk pathway and ports associated with these introductions were identified as:

- Air passenger and crew baggage from foreign countries at Los Angeles, San Francisco, and Miami.
- Express mail carriers from Hawaii to California.
- Cargo ships at Florida ports from Central America.
- Cargo from foreign countries at Los Angeles, San Francisco, and Miami; and from Hawaii to Californian locations.

The increasing frequency of Medfly infestations correlates closely with the increase in travel and trade. Although the resources available for the AQI program have increased, they have not increased at the same pace, thus PPQ's ability to stop the introduction of exotic pests in general has been reduced. In order to reduce the frequency of these introductions or even stop future increases in this frequency, APHIS must devote more resources to certain port activities at the high risk ports. Improvements in current risk management practices and the development of new approaches are needed to reduce the risk from this pest.

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1. INTRODUCTION

A. Background

Mediterranean fruit fly, Ceratitis capitata (Wiedemann) (Medfly) is one of the most serious exotic plant pests threatening U.S. agriculture. Medfly has been a major threat to large segments of agriculture for the continental United States since it was first reported established in Hawaii in 1910. The threat of Medfly invasion and the desire to eradicate Medfly infestations have been major influences for U.S. plant protection in both the regulatory and technical development areas. It has become introduced in the continental United States 18 times between 1910 and 1990 and subsequently eradicated each time. The estimated costs of each of these establishments (cost of eradication plus industry loss if any) has ranged from $300,000 to $200 million. Millions of dollars are spent each year on research to improve our ability to eradicate Medfly from the continental United States, Central America, and Hawaii, and on the development of quarantine treatments for various fruits. Little research or other resources are directed at identifying how Medfly enters the continental United States to become established or how we can more efficiently exclude Medfly.

B. Objective

The major purpose of this assessment is to identify the high risk pathways for Medfly, and to identify the operational activities necessary to reduce that risk.

This risk assessment includes:

- Pathway study of the continental United States.
- Prediction of potential U.S. distribution.
- Economic impact assessment (cost of eradication compared with other alternatives).
- Identification of operational changes that may reduce risk.
- Identification of research needs for assessment and exclusion purposes only.

This assessment does not include:

- Recommendation on APHIS' response to establishment.
- Identification of research needs for eradication or survey procedures.

C. Scope

Information from a variety of sources was collected and used for this assessment. Because of the long duration of this assessment, the assessor was

able to develop and use certain information which would not normally have been available. These included projects involving the rearing of suspect Medfly from African peppers, collecting and rearing of Medfly from a U.S. infestation for fingerprinting and several on-site visits to high risk PPQ ports. The following sources of information were utilized or developed for use during the assessment.

(1) Published Literature on Medfly

A general review of the world literature on Medfly was completed and a more in-depth review was done on areas of more importance to the scope of the assessment. Much of the literature was available from APHIS references and files. DIALOG (a computerized bibliographic service) and the National Agricultural Library were also utilized. The publications are cited in the assessment and listed in the Reference section.

(2) Reviews and Reports

APHIS files and reports concerning Medfly, fruit flies in general, and certain pest exclusion activities were reviewed. Reports were also obtained from State Departments of Agriculture. Because fruit flies specifically and exotic pests, in general, are a major concern of APHIS, a number of fairly comprehensive studies and reviews were available such as the "Hawaiian Fruit Fly Pathways to the Mainland Evaluation, Committee Report, October 19, 1984", and the "Canadian Border Evaluation, August 1985". The reports are cited in the assessment and listed in the Reference section.

(3) Pest Interceptions

PPQ pest interception records were reviewed. APHIS maintains interception records in two databases. Information including host, origin of host, destination, and year intercepted is given in various tables in Appendix B.

(4) Rearing for Identification

At the start of this project, procedures were set up to have fruit fly infested peppers intercepted in passenger baggage from Africa sent to the National Plant Germplasm Quarantine Center, PPQ, Beltsville, MD, for rearing to adults for definitive identification. The identity of these fruit fly larvae was previously questionable.

(5) Fingerprinting for Source of Infestation

Arrangements were made at the start of this project to have infested fruit sent from new U.S. Medfly infestations and reared to adults at Beltsville, MD, by PPQ. ARS researchers could then make electrophoretic comparisons of enzymes between the specimens from the new infestation with known populations of Medfly in the world to help determine the source of the new infestation.

(6) Passenger Travel Data

The major sources for information on passenger travel were the Hawaii Visitors Bureau, the U.S. Immigration and Naturalization Service, the U.S. Department of Transportation, and PPQ.

(7) Onsite Review of Port Activities

Site visits at PPQ and IS work units in high risk areas were completed during this project. They included:

- Southern California (San Diego and Los Angeles)
- Mexico (Tijuana)
- Florida (Miami, Key West, and Tampa)
- Hawaii (Honolulu, Lihue, Kona, and Kahului)

(8) Expert Meetings

Meetings were held in San Diego, Los Angeles, Miami, Tampa, and Honolulu to help evaluate Medfly pathways. Participants included PPQ, ARS, State, and county agricultural workers experienced with Medfly, fruit flies, and quarantine activities. Summaries of an opinion questionnaire and lists of participants are included in Appendix C. Informal discussions on this subject were held with a number of other State and Federal personnel during the onsite reviews and at other locations during this project.

2. ASSESSMENT

A. Hosts and Distribution

(1) Distribution and Spread

Medfly occurs in most of Africa, the Mediterranean areas of Europe and Asia, southwestern Australia, Hawaii, and most of Central and South America. This pest originated in sub-Sahara Africa and spread to the Mediterranean area, Australia, Hawaii, and South America between 1829 and 1910 (Gonzalez, 1978 and Back, 1918). Between 1955 and 1975 it became established in Costa Rica and spread throughout most of Central America (Gonzalez, 1978).

The Medfly invaded and became introduced 18 separate times in the continental United States, several times each in Mexico and Chile, in Australia, (Victoria, New South Wales, and Tasmania) in New Zealand, in Bermuda, and in Belize (Weems, 1981). Each time Medfly invaded the continental United States it has been eradicated. From the other locations named above, it has been eradicated or otherwise died-out. As of this date, Medfly is not known to occur in these locations except for the northernmost part of Chile. For details of the U.S. invasions, see Appendix A of this report.

A country-by-country listing where Medfly is known to occur is given in the publication "Pests Not Known to Occur in the United States or of Limited Distribution, No. 26: Mediterranean Fruit Fly" (USDA, 1982). Since this has been published, it has also become established in Colombia (Herb Murphy, Area Director, International Services, APHIS, personal communication) and has been reported to occur in Bahrain (American Embassy, Manama, Bahrain, 1990). In other publications, Jamaica is listed as being infested with Medfly. This is incorrect. Also in some older sources of information, "various Pacific islands" is listed under distribution for Medfly. The only Pacific islands known to be infested with Medfly are the Hawaiian Islands.

(2) Hosts

Medfly larvae are reported to feed on up to 400 plant species. Usually the fruit is attacked but it can feed in other plant parts such as the blossom. Many of these plants are only known to be attacked under laboratory conditions and many others have only been found infested with Medfly once or twice in the field. For a comprehensive list see

Weems (1981), an extensive unpublished list of hosts compiled by PPQ (USDA, 1985), or Liquido, *et al.* (1991).

The most common hosts for Medfly are stone fruits, pome fruits, citrus fruits, and coffee berries. Weems listed 42 fruits as being heavily or generally infested. It should be noted that the preferred hosts change from region to region. For example, citrus is the preferred host in the Mediterranean area but not in Hawaii where coffee is the major host. PPQ's interception records reflect this (Appendix B).

In the next few paragraphs specific information is given on the distribution and host relationship of Medfly for three geographic locations that are possibly the major sources of origin of the U.S. infestations of Medfly.

(3) Medfly in Central America

Medfly was first discovered in Central America in April 1955 near San Jose, Costa Rica. It then spread into Panama and Nicaragua. By 1977, Medfly had spread into El Salvador, Honduras, Guatemala, and the southern border of Mexico (Gonzalez, 1978 and Rhode, 1976).

Species of fruit flies belonging to the genus Anastrepha are important pests of tropical fruits in Central America. Although Medfly does attack some of these tropical fruits, such as guava and mango at low infestation levels, most of the damage is caused by Anastrepha spp. (Jiron and Hedstrom, 1988). Medfly has been found to infest at least 38 host plants in Guatemala (Eskafi and Cunningham, 1987). The primary hosts of Medfly in Central America are coffee, tangerine, orange, grapefruit, peach, and tropical almonds (Henning, *et al.* 1986). In the areas where coffee is grown, Medfly infests coffee berries and maintains a fairly high population until the coffee is harvested (around late February in Costa Rica). The pest then moves to citrus, peaches, and other hosts. At generally lower elevations in towns, Medfly populations are maintained on tropical almond and backyard mixed fruit plantings (Henning, *et al.* 1986).

In Costa Rica, Panama, and Nicaragua, Medfly is the only fruit fly pest of citrus, but in Guatemala the Mexican fruit fly is a major pest of these hosts (Eskafi, 1988).

The Medfly population diminishes during the rainy season in Central America. In Costa Rica, the rains start in April and extend to the

end of the year with the Medfly population at a low by July (Henning, *et al.* 1972). In Guatemala, the highest adult Medfly population occurs in March but can vary depending on elevation. The population is lowest in September and October. The highest fruit infestation rate occurs in May. The population peaks coincide with the maturation period of the host fruits, particularly coffee. The population lows coincide with increased rainfall (Eskafi and Kolbe, 1987).

(4) Medfly in Hawaii

Medfly was first found in Hawaii in 1910 and quickly spread throughout the major islands. In 1946, however, oriental fruit fly was accidentally introduced to Hawaii and has displaced Medfly from much of the area it once occupied (Nishida, *et al.* 1985). In Hawaii, the oriental fruit fly is a much more common pest. Currently, Medfly is generally confined to areas between 2,000 to 4,500 feet above sea level and occasionally at lower elevations around citrus, tropical almond, coffee, and other fruits (Harris and Lee, 1977). In general, it is confined to the drier areas (leeward sides of the islands). On each of the islands, the pest is found in localized areas. The Island of Molokai has a Medfly population of low density and only at one location. The other major islands have areas of high and low densities with the largest infested areas near Kona on the Island of Hawaii and Kula on Maui (Nishida, *et al.* 1985).

The most important hosts of Medfly in Hawaii are citrus, coffee, tropical almond, fig, guava, Jerusalem cherry, loquat, mock orange, peach, persimmon, strawberry guava, Surinam cherry, and yellow guava (Nishida, *et al.* 1985). The importance of each host to Medfly changes for each location. In the Kona area on the Island of Hawaii, on Kauai, and on Oahu, coffee is the most important host. On Maui (at Kula), figs, loquat, and peaches are important (Nishida, *et al.* 1985).

Seasonal changes in the size of Medfly populations in Hawaii varies much from one location to another. Studies suggest that host availability is the most important factor in these seasonal changes (Harris, 1986). In Kula, the adult population peaks between May and October, and the peak infestations in fruit occur 8-12 weeks before, from February to April (Wong, *et al.* 1985).

(5) Medfly in the Mediterranean Area

Medfly occurs in all countries that border the Mediterranean Sea, where it is a serious pest of citrus, stone, and pome fruits. In this region, it is the only polyphagous fruit fly. In Israel, the highest

infestation levels occur in guava, pitanga, avocado, strawberry guava, white sapote, feijoa, plum, and fig (Avidov and Harpaz, 1969).

(6) Potential Range in the Continental United States

Medfly could occur in all of Florida, much of Alabama, California, Georgia, Louisiana, and Mississippi; and in parts of Arizona, South Carolina, and Texas. The following factors were considered in estimating the potential range:

- Comparing climatic conditions where Medfly is known to occur to U.S. areas (Worner, 1988; and Dowell, 1983),
- Host availability considering types, quantity, and seasonal phenology (Galt and Albertson, 1981),
- Place and size of previous U.S. infestations, and
- Laboratory data on climatic limits for Medfly (Messenger and Flitters, 1954).

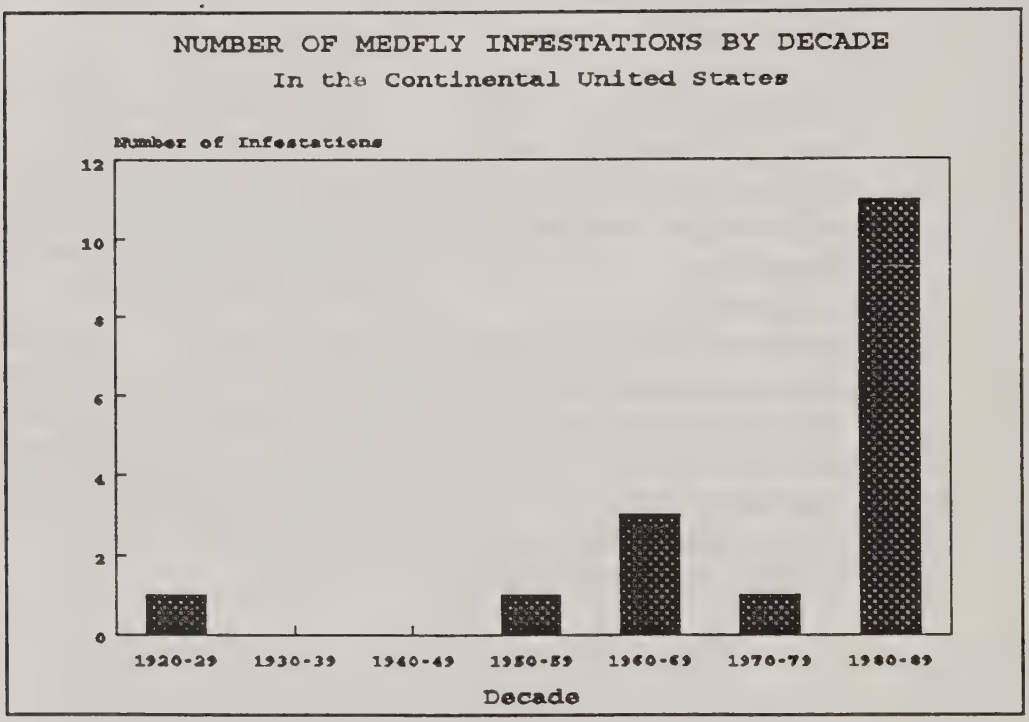
Within Medfly's potential range, its' population density and the economic damage would vary from area to area depending on the seasonal availability of hosts and the presence or absence of unfavorable climatic conditions. Much of Florida would maintain high populations because of both favorable climate and availability of preferred host material throughout the year. In other areas such as southern Texas and eastern Georgia, absence of good hosts during certain seasons would limit population growth. In the northern limits of its range, the yearly abundance of Medfly would be determined by the severity of the most recent winters. In fact, the northern limits of its range would fluctuate; after several mild winters, the pest would spread north and then this range would again contract after colder winters as occurs in Europe.

B. Detection of Medfly in the United States

(1) Frequency

Between 1929 and 1990, Medfly has been detected 32 times in the continental United States; 18 of these met USDA criteria for infestations and USDA initiated eradication programs. In 14 other cases, one or two flies were captured; after trapping was intensified and no other flies were captured, it was assumed no infestations were present. (See Appendix A for summary of these detections.) The frequency of both detections and infestations has increased drastically over time.

FIGURE 1



(2) Invasion in Hawaii

Medfly was first detected in Hawaii in 1910 in the Honolulu area on the Island of Oahu. By 1914, the fly was known to occur on all major islands in Hawaii. It is believed that Medfly became established in Honolulu, Hawaii, a few years prior to detected, about 1907 (Back, 1918). It was speculated that Medfly became established in Hawaii from flies escaping from a ship(s) docked in Honolulu. The ships destined to Vancouver, Canada, carried Australian apples on deck (Weinland, 1967).

(3) Detection in Florida

One-half of the 18 continental U.S. infestations including the first four (1929, 1956, 1962, and 1963) and one-half of the 14 other occurrences (noninfestations) of Medfly have occurred in Florida. All of these occurrences except two were first detected in or around Dade County. The two exceptions were the 1929 infestation which was first detected in Orlando and the 1981 Tampa infestation.

The first two infestations (1929 and 1956) occurred before any active detection program existed and at the time of the detection the infestations were already large and widespread. It is not known in what areas or during what times of the year these infestations started; thus, there are no clues as to what pathways and from where these infestations were derived. Central America can be eliminated as the likely source of these two infestations because Medfly was not detected in Central America until 1955 and was not widespread until years later.

Three of the infestations (1962, 1963, and 1990) and one of the single fly catches (1983) occurred in or around Miami Springs. Miami Springs is a small upper income housing area containing single unit housing, condominiums, and hotels located on the northern edge of the Miami International Airport. In at least the 1990 infestation and possibly others, the first flies detected were within a few blocks of the airport, adjacent to cargo areas. The source of these flies could have been from the cargo area of the airport directly associated with garbage, or whole fruit from airplane stores, shipments of smuggled fruits, and/or fruit with shipments of live animals including birds. The other likely source of the flies would be directly from the residences of Miami Springs. Because of the upper income nature of this community, few new immigrants live there. However, airline personnel including flight crews live in Miami Springs, and because of the active international

trade in Miami, wealthy foreign nationals from Medfly countries also live in this area.

Several Medfly occurrences in Florida are closely associated with ship and boat traffic.

- In 1964, a single fly was trapped near Pier 3 in Miami. This was believed to be an escapee from a merchant vessel from Hawaii (Clark and Weems, 1988).
- Single flies were trapped in 1967 in Miami Beach and in 1986 in Indian Rocks Beach, both near yacht clubs.
- In 1981, an infestation occurred in Tampa. The first flies were trapped in a backyard of a largely hispanic community fairly close to a ship docking facility commonly used for cargo ships from Central America with Central American crews.
- In 1984, an infestation occurred in an area known as Little Havana, 0.5 mile from the Miami River. The initial adult and later a larva from a sour orange were taken from a homeowner who was a crew member of a cruise ship. Most cruise ships generally use only U.S. stores, and most visit no Medfly countries; although a few of the ships will take 2-week trips to South American ports and some of the ships will have European stores. Small cargo ships with Central American crews dock on the Miami River.
- In 1984, two flies were trapped on Dodge Island during the same time period as the Little Havana infestation. Dodge Island is a manmade island used by cruise and cargo ships and is void of Medfly hosts. It is believed that the flies were from one of the ships (Clark and Weems, 1988).
- In 1990, one fly was trapped at Port Everglades, Fort Lauderdale.

The other three occurrences of Medfly in Florida are not strongly associated either with airports or seaports.

- A 1985 infestation in North Miami and a 1987 infestation in Hialeah both occurred in largely blue collar Hispanic communities although the North Miami infestation was about 1 mile from the Opa Locka Airport, a small regional airport with some international flights.
- In 1988, one fly was trapped in a trailer camp located in Sweetwater, Dade County. A door-to-door survey conducted by the State found that one family moved into the trailer camp from Nicaragua about 3 weeks before the fly was captured.

(4) Detection in Texas

The only occurrence of Medfly in Texas was an infestation that occurred in Brownsville, Texas, in 1966. There is nothing to indicate what caused this infestation except that people moving overland from Central America to the eastern half of the United States normally pass through Brownsville or associated with agribusiness connections that exist between southern Texas and Central America.

(5) Detection in California

Eight Medfly infestations have occurred in California since 1975. In addition, single Medflies have been captured seven other times.

(a) Los Angeles Area

Since the first infestation in the Los Angeles area in 1975, Medfly has become established there six times. In addition, Medfly adults that were not associated with an infestation have been trapped five times since 1982.

Most of these Medfly infestations and detections mentioned above occurred in Los Angeles County. This county is made up of a variety of urban housing areas from high to low income housing. A large percentage of the population has connections with people in areas where Medfly occurs such as Europe, Central America, and Hawaii. Several universities in the county have large foreign enrollments. About 95 percent of the population in the core area of the 1987 Medfly infestation is Hispanic with friends and family from Central America. The Medfly detections in Los Angeles County have occurred all over the county with little or no direct association with either airport or seaport activities.

The single fly captured in Orange County in 1987 was trapped in an area known as Little Saigon. Many of the people living there have Vietnamese or other Southeast Asian backgrounds. Most of the fruit found in domestic mail from Hawaii by county inspectors was destined to this area.

One Medfly was captured in Santa Barbara County in 1984. At the time the fly was captured, the 1984 Olympics was taking place, and some of the games were held in Santa Barbara County. The fly was captured near a county dump and housing units in which two families resided who had recently returned from Hawaii.

Santa Barbara County has a very high per capita income and few people with strong ethnic ties to areas where Medfly occurs.

Besides Medfly infestations, the Los Angeles area has been infested by several other species of exotic fruit flies. Examples are Mexican fruit fly (1983), peach fruit fly (1984 and 1987), guava fruit fly (1986), and oriental fruit fly (numerous times).

(b) San Diego County

Medfly has not successfully established itself in San Diego County. Two single trap catches (one in 1980 and one in 1986) of Medfly have occurred. One was trapped in Coronado and the other in Mt. Helix. These are upper-income residential sections in the Great San Diego area. Coronado is next to the ocean, and Mt. Helix is inland. One connection to a pathway that was voiced was that the people living in these areas can afford to vacation in Hawaii, and many do. Additionally, many retired Navy personnel reside in Coronado.

(c) Santa Clara County

Medfly infestations occurred in Santa Clara twice (1980 and 1989). Neither infestation can be closely linked with seaport or airport activities. A door-to-door sociodemographic survey was conducted for the 1989 Mountain View infestation by APHIS Legislative and Public Affairs Staff and CDFA. They found the neighborhoods in the infested area to be solidly middle income with single family housing, comprising about three-quarters of the residences. The population was 79 percent white, 12 percent Hispanic, and 9 percent Asian. About one-third of the residents have traveled to Hawaii or foreign locations, including many who traveled to Europe or Hawaii within the last year. Fifteen percent had visitors from outside the continental United States and about 4 percent received produce from friends or family in Hawaii or foreign locations (Brown, *et al.* 1989).

C. Review of Interception Data

(1) General Assessment

Since 1971, PPQ has intercepted Medfly at ports of entry about 1,500 times. One-half of this total came from the Mediterranean area and about one-third was from Hawaii (Table 1, Appendix B). About half the interceptions from Hawaii were from coffee berries. The interceptions from the Mediterranean countries were commonly found in peaches, cactus fruit, apples, and citrus fruits (Table 3, Appendix B).

The large majority of interceptions is from passenger baggage. For example, between 1980-1987, PPQ intercepted Medfly 587 times; 560 of these were from passenger baggage, three from mail, and 24 were from airplane or ship stores and quarters (Table 2, Appendix B).

From Hawaii, the oriental fruit fly is intercepted about ten times more than Medfly (Table 4, Appendix B) and from Latin America, species of Anastrepha fruit flies are intercepted many times more often than Medfly (Table 8, Appendix B).

(2) Biases in Data

Interceptions of quarantine pests by PPQ serves as a valuable source of information. Information gained from pest interceptions helps determine entry status of agricultural material and identifies high risk pest situations. However, interceptions are not taken by a systematic sampling method, thus interception data are biased. Some of the factors that bias interception include the following:

- The bias of a given exclusion activity for finding interceptions compared with other activities. For example, few fruit fly interceptions occur in ship boarding activities compared with passenger baggage clearance, simply because fruit cutting is not routinely performed at most locations during ship boarding and clearance.
- The bias in the selection of the type of fruits cut. Inspectors are more likely to use their limited time at cutting fruits such as mango and guava from Central America which are commonly infested with Anastrepha. They are also less likely to cut other fruits such as citrus and papaya which are less likely to be infested with Anastrepha but may be infested with Medfly.
- The smaller sized Medfly larvae are more difficult to find in fruit compared with the larger Anastrepha larvae.

• The bias in profiling. For example, on Central American flights, the inspector is more likely to X-ray and/or open baggage of Hispanics over non-Hispanics. The first group is more likely to have good Anastrepha hosts, such as mangos. The second group is likely to have few fruits, but may have picked up tropical almonds from their beach resorts or coffee berries from plantation tours. Both these fruits are good hosts for Medfly.
• The bias between port of entry. Certain ports place greater emphasis on finding pests.

Beside biases mentioned above there is at least one source of error that may affect this data. The destinations reported on the interception form by PPQ officers are not always correct. The fruit seized from passenger baggage is not examined until sometime later and the destination of the passenger may not be known. The officer could list the destination as unknown, but many times it is recorded as the same State as his duty station; thus, States with large ports of entry (e.g., New York) tend to be over reported.

A second possible source of error is with the identification of the pests. Larval stages of fruit flies are very difficult to distinguish between. Since other fruit flies are commonly intercepted from Central America and Hawaii, Medfly is possibly under estimated from both these locations.

(3) African Peppers

PPQ has intercepted fruit fly larvae in green peppers (Capsicum sp.) carried in passenger baggage from various sub-Sahara African countries. These interceptions were identified as Ceratitis sp., Ceratitis capitata or as species of Tephritidae. The true identity of these fruit flies was in question because peppers are generally not considered a good Medfly host and because of the occurrence of various related fruit flies in sub-Sahara Africa. As part of this project, BATS reared to adults, fruit fly larvae taken from infested peppers seized at ports of entry. Adults were reared and identified as Medfly from infested peppers from Nigeria, Zambia, Liberia, and Ghana. No other species of fruit fly were reared from the peppers.

D. Pathways

In this section, the various potential pathways for the movement of Medfly into the continental United States are examined. For each pathway, evidence is given to determine the risk for the entry and establishment of Medfly. The information used concerned:

- evidence of Medfly and Medfly host entry
  - -- pest interception records (considered the best evidence)
  - -- host interception records
  - -- probability of host material being infested
  - -- expert opinion
  - -- opportunity and motive
- evidence of quarantine control effectiveness
  - -- formal evaluations
  - -- expert opinions
- potential for establishment
  - -- size of shipment or potential number of specimens
  - -- potential of Medfly arriving at a favorable environment for establishment

In addition, certain potential high risk ports of entry are assessed specifically. In all of the pathways listed below except the last, only immature Medfly associated with infested host material is considered. The last pathway assesses the risk of adults and pupae not associated with host material.

(1) Passenger and Crew Baggage from Foreign (Airport)

Large numbers of Medfly interceptions, large amounts of intercepted host material, the poor quality of a large percent of the host material, PPQ inability to stop the entry of a significant amount of this host material, and the movement of this material to favorable environments for establishment makes this pathway high risk.

In recent years (1980-1987), Medfly has been intercepted in baggage from foreign sources 442 times. This accounts for 75 percent of the total interceptions of Medfly. Three hundred and seventy-three of these interceptions originated from the Mediterranean area (Table 2, Appendix B). To some degree, the disapportionately large amount from the Mediterranean may be caused by the various biases mentioned in Section C. For example, Los Angeles is a major port of entry for passengers arriving from Latin America and large amounts of Medfly host material is seized but not all is examined for fruit fly infestation. If ports of entry that receive most of the flights from

Europe examined the fruits thoroughly, the above totals could be explained.

About 34 million people arrived at U.S. airports (about 90 locations) from foreign countries (excluding arrivals from Canada, Bahamas, and Bermuda) in FY 1989. Passengers arriving from Bermuda, Bahamas, and parts of Canada are precleared. A total of 30 million of these, or 89 percent, arrived at 14 U.S. airports (Table 1). At these 14 locations, the typical method that PPQ uses for clearance is as follows:

- PPQ officers designated as "rovers" profile passengers in the baggage claim area. The passengers who fit a certain profile that would make them likely candidates for carrying agricultural material are referred to secondary inspection. In addition, passengers that answer yes to either of the two agricultural questions on their Customs declaration are referred to secondary inspection. In eight of these locations, PPQ uses dogs in the baggage claim area to cover some of the flights.
- In secondary, the baggage is X-rayed and depending mostly on the results of the X-ray, a percentage of the baggage is opened and inspected.

At all other locations, PPQ either (1) uses rovers and physically inspects baggage in secondary, or (2) U.S. Customs interviews each passenger, inspects a portion of the baggage and refers passengers with agricultural material to PPQ.

In 1989 by the above methods, PPQ made 549,335 seizures of prohibited plant material including fruit fly host material. A large percentage of the passengers carrying the prohibited material came from countries where Medfly occurs.

No records are kept on a national level of how many of the passengers are sent to secondary or what percentage of the baggage is opened and physically searched. In the summer of 1989, Tom Schatzki, ARS, completed a study of the passenger clearance process at the main foreign arrivals area in Los Angeles. Part of his finding indicated that 8 percent of the passengers are referred to secondary and their baggage X-rayed. Of the baggage that is X-rayed, 13 percent is opened and physically inspected, thus, less than 1 percent of the baggage arriving is opened and inspected.

Table 1 - Clearance of Airport Passengers and Crews from Foreign Countries - FY 1989 (excluding arrivals from Canada, Bahamas, and Bermuda)

Airport	People (millions)	Rovers	X-Rays	Dogs
1. JFK, NY	9.04	Yes	Yes	Yes
2. Miami, FL	4.27	Yes	Yes	Yes
3. Los Angeles, CA	4.21	Yes	Yes	Yes
4. Honolulu, HI	2.69	Yes	Yes	No
5. San Francisco, CA	1.68	Yes	Yes	Yes
6. O'Hare, IL	1.60	Yes	Yes	Yes
7. Dallas/Ft.Worth, TX	1.23	Yes	No	No
8. San Juan, PR	1.17	Yes	Yes	No
9. Houston, TX	1.02	Yes	Yes	Yes
10. Boston, MA	.98	Yes	Yes	Yes
11. Elizabeth, NJ	.66	Yes	Yes	No
12. Seattle, WA	.64	Yes	Yes	Yes
13. Dulles, VA	.61	Yes	Yes	No
14. Atlanta, GA	.53	Yes	Yes	No
All Others	3.75	Some	No	No
TOTAL	34.08			

The percentage of baggage X-rayed or physically searched would change from airport to airport depending on such things as the percentage of high risk profile passengers, the availability of X-rays and dogs, and the availability of PPQ officers.

The risk of this pathway would depend on how much of the host material is not found by PPQ, type of fruit (preferred host or not), number of fruit per lot, condition of fruit, origin of fruit, growing condition at origin, and destination of fruit in the United States. Generally, baggage shipments of agricultural material are considered higher risks than commercial shipments of the same material. A large portion of fruits carried in baggage are backyard grown, picked ripe,

and not subject to a routine pesticide control program. Also commercially grown fruits from most of Latin America are not normally field treated for fruit flies. While the generally small lot size of baggage shipments lessens the risk for many exotic insect pests, this is not entirely true for fruit flies. A relatively large number of fruit flies can infest a few fruits. The colonization potential for Medfly is such that two or three guava fruits or a handful of coffee berries pose a significant risk.

An indication on the effectiveness of our baggage clearance process can be gained by the 1989 Los Angeles study by ARS. The study indicated that an average of 334 bags containing prohibited agricultural material arrived with passengers daily. Twenty-five percent of these were referred to secondary for X-ray examination. Forty-five percent of the bags containing prohibited material that were X-rayed were opened; thus 89 percent of the bags arriving with prohibited material went unfound by PPQ. It must be stated here that only a portion of this was fruit fly material, the profiles used by our inspectors are designed to identify people that would carry high risk material, the dogs are trained to find high risk material, and whole fruits are easier than some other prohibited material to find with X-rays. In the above study, a ham sandwich or one commercially grown apple taken from an airline meal was counted the same as a baggage lot of ten backyard-grown mangoes.

Another indication on the effectiveness of baggage clearance is shown by a May 14-20, 1990, blitz which was conducted by PPQ/State/County inspectors in Los Angeles. In this blitz, 100 percent of the baggage from targeted flights was inspected and a larger than normal percentage of baggage of nontargeted flights was inspected. Fifty-three State and county employees assisted the 28 PPQ officers. The result was that 46 percent more prohibited plant material was found than normal. The records from the blitz also indicated that a large percentage of the plant material is fruit fly hosts, especially from Latin America (California Department of Food and Agriculture, 1990).

Participants of expert meetings in Los Angeles and Miami, in general, rated this as the most important Medfly pathway for their area.

(2) Air Passenger and Crew Baggage from Hawaii

In 1989, about 4.7 million people arrived by air to the mainland United States from Hawaii. The passenger and crew baggage is cleared in Hawaii by PPQ. The large majority of clearance activity takes place at the Honolulu International Airport. Passengers on direct flights to the

mainland are also cleared at commercial airports in Kona, Kahului, and Lihue, and at Hickam Air Force Base in Honolulu. In addition, many people fly to Honolulu on inter-island aircraft and then depart Honolulu on another plane. Their pit baggage is cleared in Hilo, Kahului, Kona or Lihue, and the carry-on baggage is cleared in Honolulu. Almost all baggage from Hawaii is cleared with the aid of X-ray machines. The exceptions are baggage of people departing from Hickam Air Force Base and some of the carry-on baggage of passengers on direct mainland flights from some of the smaller airports.

In recent years (1980-1987), Medfly has been intercepted in baggage from Hawaii 118 times. This is 20 percent of the total interceptions of Medfly. In 1989, PPQ seized about 150,000 lots of prohibited plant material from passenger and crew baggage. A large percentage of this plant material was fruit fly host material.

The effectiveness of the PPQ clearance process of passenger baggage from Hawaii depends largely on how effectively the PPQ personnel are at detecting prohibited material using X-ray. Unlike passengers from foreign locations, they are not required to fill out a Customs declaration on which they must state if they have any agricultural material. Nor are most of the passengers verbally asked if they have any fruits or other plant material. We could assume that the officers in Hawaii would find about the same percentage as they did in Los Angeles (45 percent) by using the X-ray and because larger fruits (such as orange, mango, guava) are generally easier to find, much of the fruit fly hosts would be found.

During the May 1990 blitz in Los Angeles, officers reinspected baggage from seven flights that were cleared in Hawaii. A PPQ dog team was used for the 1,738 passengers, and baggage of the 83 flight crew members was opened and inspected. Seven interceptions of fruit were made: four apples (one from a crew member), two oranges and one banana. Most or all of these were probably of mainland origin and came from permitted airline or airport sources.

One question that needs to be answered is the importance of coffee berries and tropical almonds in baggage shipments as a pathway of Medfly from Hawaii. Coffee berries are generally believed by Hawaiian PPQ personnel to be almost impossible to find by X-ray, and tropical almonds would be difficult to find. ARS has determined that coffee is the most important host of Medfly in Hawaii, and tropical almond is one of the preferred hosts. PPQ pest interceptions confirm this. Between 1970 and 1987 (Table 5, Appendix A), PPQ has

intercepted Medfly from Hawaii 705 times. The most common host was coffee (468 times) and the second most common host was tropical almond (89 times).

Because of changes in travel regulations (see page 89) and possibly in tourist behavior, the interceptions of coffee berries have decreased, but it is still the most common fruit found infested by Medfly from Hawaii (1980 - 1987).

The importance of passengers from Hawaii as a pathway for Medfly depends on their mainland destination. How many of the 4.7 million people visiting Hawaii each year are from areas in the mainland where Medfly can become established. Table 2 illustrates the importance of this pathway.

On the average participants at the expert meeting in Honolulu rated this Medfly pathway as moderate to high. Several participants believed that only about 1 percent of the fruit fly host material is missed by PPQ.

Table 2 - Visitors to Hawaii from High Risk States (1987)

High Risk States	Percent from 49 States
Alabama	.5
Arizona	1.7
California	29.1
Florida	2.1
Georgia	1.4
Louisiana	.5
Mississippi	.3
South Carolina	.4
Texas	3.7
Subtotal from High Risk States	39.7
Subtotal from All other States	60.3

Source: Hawaii Visitors Bureau, 1987 Westbound Visitors to Hawaii

(3) Aircraft (Stores, Quarters, Hold, and Garbage)

Aircraft do not appear to be a major pathway for Medfly. Even though whole fruits are removed and routinely examined for pests, Medfly is rarely found. In recent years (1980-1987), only 24 of the 587 Medfly interceptions originated from stores, quarters or holds of both aircraft and ships. In addition, this pathway would only be a real threat for Medfly for those aircraft arriving in southern ports where Medfly could become established. This is different than the clearance of passengers, where large numbers of people traveling from Europe to southern California are cleared in northern U.S. ports.

A total of over 368,000 aircraft arrived from foreign countries in FY 1989 (not including Canada) of which about 280,000 were inspected by PPQ. The others were considered low risk, and compliance agreement with airlines and catering companies help eliminate risk from these sources.

In FY 1989, a total of over 177,000 aircraft departed Hawaii destined to the U.S. mainland. Most of these aircraft are catered by companies under compliance agreements that greatly reduce the risk of fruit fly infested material being used in the aircraft stores. Aircraft that are not catered under agreements are boarded and inspected.

The effectiveness of PPQ controls of this pathway is hard to measure. The airport sanitation officer in Miami processed 49 violations concerning such things as improper garbage disposal and the removal of foreign food for personal consumption from aircraft from September 1988 to December 1989. No such violations occurred for this type of activity in Los Angeles or in Hawaii for FY 1989. Miami has a full-time officer assigned to this activity. The only other locations that have full-time sanitation or compliance officers are Miami (maritime), JFK (airport), Los Angeles, Honolulu, and San Francisco (covers both airport and seaport). Few or no violations covering this pathway are processed at airports without full-time sanitation officers.

This pathway must be considered as a possibility for the three Medfly infestations and the one single fly find occurring in the Miami Springs area which borders the airport in Miami.

Participants of expert meetings in Miami, Los Angeles, San Diego, and Honolulu consider this Medfly pathway low risk except that Honolulu considered cargo planes' stores and quarters as moderate risk.

(4) Domestic Mail from Hawaii

From around 1978 until recently, PPQ has not been involved in the clearance of first-class parcels from Hawaii because of Postal Service policy and regulations. Before that date, PPQ inspected first-class parcels and seized prohibited plant material including fruit. PPQ was allowed to inspect other than first-class parcels, but since these parcel may take several weeks to be delivered on the mainland, fresh fruit would rarely if at all be mailed by this method.

After 1978, agricultural inspectors from various California counties (they routinely visit general mail facilities within their counties for the inspection of State-regulated material such as nursery stock) made various arrangements with the local mail facilities in order to best reduce the threat from fruit flies from Hawaii. Using various methods, the inspectors were able to somewhat reduce the threat, but it was believed that most of the parcels containing prohibited fruits were not stopped. In Orange County, the agricultural inspectors believed that they were able to inspect approximately 10 percent of the packages from Hawaii containing fruits. Medfly infested fruits from Hawaii were intercepted by the Orange County inspectors once in 1986 and twice in 1987.

Since May 1990 and with the cooperation of the Postal Service, PPQ has been able to inspect, on a trial basis, first-class packages in Hawaii. Using inspectors, a dog and obtaining search warrants, PPQ intercepted 220 packages containing prohibited material mostly fruits in the first 2 months of the project. They obtained over 2,000 pounds of fruit and vegetables and intercepted oriental fruit fly larvae 12 times during this period. The average shipment contained about 10 pounds of fruit which we can assume is much larger than the average fruit lots carried in passenger baggage, thus increasing the risk of colonization. In July of 1990, three packages containing guavas infested with Medflys were intercepted. They were mailed by the same person to three different Sacramento, California, addresses. Most of the first-class parcels mailed from Hawaii are destined to West Coast States, with California being the most common destination.

In 1987, a single Medfly was trapped in Orange County in an area known as Little Saigon. Many of the people living here have Vietnamese backgrounds. Most of the fruit found by county inspectors in domestic mail from Hawaii was destined to this area. Orange County contains the largest concentration of Vietnamese in the world outside of Vietnam. Large numbers of Vietnamese have also settled in

Hawaii especially in or near Honolulu. We can assume that the most likely pathway for this 1987 Medfly was by either domestic mail or passenger baggage from Hawaii.

Participants of expert meetings (the meetings took place before the May 1990 trial inspection) in San Diego, Los Angeles, and Honolulu considered this a high-risk Medfly pathway for California. Many of them consider this the most important single pathway.

(5) Foreign Mail

PPQ conducts the clearance of mail from foreign locations at various postal facilities including Miami, JFK, Los Angeles, Honolulu, San Juan, San Francisco, and Atlanta. The methods used for this clearance vary from port to port but include the use of dogs, PPQ X-rays, profiling by PPQ officers, and reliance on U.S. Customs' use of X-ray. In FY 1989, PPQ inspected over 180,000 mail packages and made about 3,000 interceptions of prohibited plant material. In Los Angeles where one of the PPQ dog teams is assigned, PPQ inspects about 5,000 packages a year that yield about 2,000 interceptions of quarantine material including meat products. PPQ in Los Angeles estimated that between 2 to 4 percent of the intercepted material is fruit fly host material. Most of the foreign mail arriving in California is of Asian origin. It is a belief by some in PPQ that fresh fruits are rarely sent by foreign mail because the fruit would spoil due to the long delivery period.

In recent years (1980-1987), PPQ has intercepted Medfly in foreign mail three times. All of these were from the Mediterranean area.

Participants of expert meetings in San Diego, Los Angeles, Miami, and Honolulu rated the risk of this pathway from low to high. Those that were concerned with this pathway identified Latin America as the risky source.

(6) Express Carriers from Foreign Sources

Packages handled by express carriers such as Federal Express, United Parcel Service, or DHL arrive from foreign locations to various U.S. ports of entry. Most of these packages contain paper documents but since the delivery time is short and because they can easily be sent by any individual, this is a potential pathway for fresh fruits. These packages are subject to inspection by U.S. Customs, but this inspection is minimal. In Miami, the manifests are reviewed by PPQ and in Los

Angeles some packages containing agricultural material are referred to PPQ by Customs (Tween and Sudduth, 1989). At a national level, records on inspections, plant interceptions, or pest interceptions are included in the totals for cargo, thus it is difficult to assess the risk of this pathway.

Participants of expert meetings in Los Angeles and Miami rated this pathway as low. Participants in San Diego rated it as high.

(7) Express Carriers from Hawaii

Several companies including Federal Express, Purolator, UPS, DHL, and Emery move large amounts of parcels from Hawaii to the mainland United States on a daily basis. In a PPQ Honolulu report, it was estimated that 5,000 parcels per day move to the mainland from Hawaii. In a 2-year period ending in January 1989, PPQ made 99 interceptions of prohibited material from this source. Nineteen of these interceptions (over 200 lbs.) were fruits and vegetables including papaya, custard apples, mountain apples, kiwi fruit, mangoes (21 lbs.) avocados, and starfruit. About one half of the intercepted material was destined to California. The average weight of the fruit and vegetable interception was over 10 pounds (Ching, 1989).

PPQ clearance of these packages takes place mostly in Honolulu with some inspections on the neighbor islands. The method of clearance (profiling the closed parcel) is not considered fully satisfactory by PPQ in Hawaii, and they were evaluating the possibility of using a portable X-ray.

The participants of the expert meeting in Honolulu rated this as a high risk Medfly pathway. One participant rated it as the most important pathway from Hawaii. The participants estimated that a high percent of the prohibited material is missed.

(8) Cargo Ships (Stores, Quarters, Holds, Garbage, and Crew Baggage)

In general, this does not appear to be a major pathway for Medfly. The most likely way that Medfly would become established via this pathway is for a crew member to remove infested fruits either from the ship's stores or from their personal property from the ship. The ship would generally have to be docked in a southern U.S. port with host crops available in the general area.

In recent years, PPQ has made few Medfly interceptions from ship stores of cargo ships, but PPQ does not routinely cut and examine fruits from ship clearance activity. The quality of the fruit found in ship stores has improved over the years from most Medfly-infested areas thus the risk is greatly reduced.

In general, PPQ boards and clears most foreign flag vessels which arrive from a foreign port. Certain low-risk vessels are deferred. Foreign flag ships moving coastwise from one U.S. port to another are generally deferred. Coastwise ships are boarded on arrival if they have a history of garbage violations or if they arrive at southern ports with fruit fly host material in the stores. Most American flag ships are not boarded. Ship stores containing fruit fly host material from fruit fly countries are sealed by PPQ in southern U.S. ports.

As stated above, in general, this does not appear to be a major pathway for Medfly, but a situation in Florida is of concern. Established trade routes between various Caribbean and Central American countries and Florida ports exist. Small to medium size general cargo ships commonly travel these routes. Most common are small wooden ships from Haiti with Haitian crews docking in the Miami River and medium-size cargo ships from Central America with Central American crews docking in the Miami River and in Tampa. The same ships continually call in the same ports in Florida. Many of the crew members have family and friends located at the Florida ports of call. Medfly is not known to occur in the Caribbean, so Haitian ships do not represent a serious Medfly risk but should be of some concern for the West Indian fruit fly. In Miami and Tampa the ships dock at areas close to large Hispanic housing areas with a significant population of Central Americans, and in both cities host trees are common and close to the docking areas. Another factor that increases the risk is that the probability is high that fruits from these ships are likely to be infested with some species of fruit fly since neither backyard nor commercially grown fruit is generally field controlled for fruit flies in Central America. The same situation may occur at other Florida ports or other gulf coast ports, but this does not appear to occur in California.

The major risk from these ships is from the unauthorized removal of whole fruits from the ship. Crew members could hide and later remove a few fruits for family and friends, or they could hide and later remove several boxes of exotic fruits for sale in the largely Hispanic neighborhoods. Routine ship clearance by a PPQ officer has little chance of stopping this situation because of the large number of places for fruit to be hidden aboard ships.

Another risk from ships in Florida is the improper handling of ship garbage. Garbage violations commonly occur with ships docked on the Miami River. Because of the availability of host material on land this becomes a significant risk.

Detections of Medfly in the continental United States that could be associated with this pathway includes:

- A 1964 single fly capture near pier 3 in Miami (possibly escaping from a cargo ship from Hawaii).
- The 1984 Little Havana infestation close to Miami River docking areas.
- A 1984 double fly capture on Dodge Island, Miami, next to cargo and cruise docking areas.
- The 1981 Tampa infestation.

Participants at expert meetings in Los Angeles and Honolulu, in general, rated this as a low risk pathway. Participants in Miami rated this as a moderate risk pathway.

(9) Cruise Ships (Stores, Quarters, Garbage, and Baggage)

This pathway poses little or no risk for Medfly. Most cruise ships sailing from U.S. ports use U.S. fruits. On ships with foreign stores the fruit quality is high and unlikely to be infested. Passengers on cruise ships that take fruit ashore on their return to the United States almost always take fruit originating in ship stores and not from the foreign ports they visited. Almost all cruise ships traveling from U.S. waters tour non-Medfly countries (Mexico, Canada, and the Caribbean Islands). A few 2-week or longer cruises travel to South and Central American countries. Garbage is rarely a problem on cruise ships. If some risk exists, it would be from crew members. Many of them are of an ethnic background with a penchant for tropical fruits (e.g., Central American or Filipino) and have access to ships cold store rooms. They could obtain fruit in Central America, South America, or Hawaii. If the risk for Medfly is chiefly with crew members, then those cruise ships docking in high risk areas, mainly Florida and California, pose some threat. Participants at the various expert meetings generally rated this pathway as low.

(10) Yachts (Stores, Quarters, Garbage, and Crew)

Generally yachts are considered low risk. In Florida pleasure boats are common. Of those that arrive in Florida from foreign countries, the vast majority travel from the Bahamas and a few from various Caribbean countries and Mexico. Rarely do these arrive from locations where Medfly occurs. In addition, few arrive with whole fruits aboard. In California, most yachts arriving from foreign countries are from Mexico or Canada with a few arriving from Central America. Also yachts arrive from Hawaii. Again, it would be rare for these to have fresh fruit on board.

The U.S. Customs and USDA clearance of yachts varies from port to port. In San Diego, U.S. Customs clears all yachts arriving from foreign countries and seizes any fresh foods found on board. In Los Angeles, the PPQ compliance officer works on information programs with the marinas (Tween and Sudduth, 1989). In Miami, U.S. Customs generally clears yachts over the telephone with no PPQ involvement. At Key West, yachts are generally boarded and cleared by both Customs and PPQ. In Tampa, PPQ boards some yachts.

Participants at the various expert meetings generally rated this pathway as low.

(11) Naval Ships (Stores, Quarters, Garbage, and Crew)

Generally, U.S. Navy ships are considered low risk. The fruits in ship's stores are generally of U.S. mainland origin. Fruits obtained from foreign origin are usually eaten or discarded before arriving in U.S. waters. Garbage violations are rare. Many large naval facilities are not located in high risk areas for Medfly. The exceptions are San Diego and Jacksonville, which have large U.S. naval facilities. The situation there poses at least a moderate risk for Medfly. Several times each year U.S. naval ships arrive in San Diego after stopping off at Hawaii enroute from Asia. Several thousand sailors disembark at a time. Most of these people pose little risk. The normal provisions also pose little risk. They generally buy provisions from the U.S. mainland products and rarely arrive with fruit fly host material from infested locations in the normal provisions. A significant percentage of the food-handling personnel on these vessels fall under a high risk profile. This includes a number of first and second generation Filipinos. They are familiar with various tropical fruits that can be obtained in Hawaii. They often have friends or family in Hawaii who can acquire the fruit

and they have access to the ships cold store rooms. Small personal lots of prohibited fruits have been found either in cabins or stores on these ships in the past. Inspection of all sailor baggage would be impractical.

Non-U.S. military ships are given courtesy of the port and little actual inspection occurs onboard, but strict control over host material leaving the ship is maintained. It appears that the risk is minimal.

In August 1986, one adult Medfly was trapped in Coronado, San Diego County, California, close to U.S. Naval facilities and housing areas where naval personnel commonly live.

Participants at the various expert meetings generally rated this pathway as low risk.

(12) Fishing Ships (Stores, Quarters, Garbage, and Crew)

This appears to be a minor pathway. PPQ clearance of fishing ships is similar to that of cargo ships. No moderate or high risk situations concerning fishing ships were identified except for one situation in Tampa. A few shrimp boats dock in Tampa with Central American crews. The crews are known to have friends or family in Tampa. On one such ship four birds from Honduras were found hidden onboard.

(13) Cargo, General

The risk of Medfly becoming established from infested fruits arriving in the mainland United States as or with cargo is difficult to estimate but should be considered as at least moderate. Host fruits can and have entered the United States with cargo by three methods.

- A whole shipment of prohibited fruits arriving as cargo and mismanifested or misidentified as a non-agricultural product.
- A small lot of undeclared prohibited fruits arriving hidden under or behind large shipments of permitted cargo.
- A small lot of prohibited fruits (undeclared or mismanifested) arriving with a shipment of mixed fruits or vegetables.

The potential risk of Medfly becoming established when host fruits are smuggled in by way of cargo shipments is significant. By this pathway, a few boxes to several hundred boxes could arrive at once. Thousands of Medfly larvae could be present; thus the probability of Medfly becoming established is much higher than if a few fruit (containing a few larvae) are smuggled in via passenger baggage. How often are host fruits smuggled into the U.S. mainland? On rare occasions, PPQ has found prohibited fruits being smuggled in by way of cargo shipments. Examples of these are:

- Five cases of Italian blood oranges found with an air shipment of endive and shallots shipped under the Belgium preclearance program (found in Tampa, Florida).
- Several cases of Venezuelan mangoes arriving by air found hidden under crates of bananas in Miami, Florida.
- Sea containers of sandpears arriving in California from Korea manifested as canned goods (not a Medfly country).
- 18 containers of golden apples arriving in New York from Trinidad (not a Medfly country) hidden under a shipment of crabs.

From July 23 to 27, 1990, a cargo inspection blitz was conducted at the Los Angeles International Airport by 22 State, Federal, and county inspectors. Cargo originating from Medfly countries and Hawaii was targeted, and cargo from other areas was inspected as time permitted. All cargo arriving on targeted flights was inspected. A total of 1,387 shipments were inspected (686 from targeted countries and 185 from Hawaii). Eighteen shipments were found mismanifested or undeclared, and two of these contained fruit fly host material. One was luggage shipped as cargo containing 24 kg of lychee from Taiwan (a non-Medfly

country) arriving via Canada. The other was one box containing one pepper fruit manifested as non-agricultural products.

These finds indicate that cargo could be a significant pathway for Medfly but our ability to find smuggled fruits in cargo is limited because of the large volume of cargo. Cargo arriving from Hawaii poses additional risk because it lacks U.S. Customs control and the short shipping time negates refrigeration requirements.

Most of the U.S. Medfly infestations and single fly finds could have been associated with this pathway. They would include the four Medfly finds in Miami Springs, Florida, and the Medfly occurrences in heavily ethnic housing areas (e.g., Little Havana, 1984; Tampa, 1981; Little Saigon, 1987; and several of the Los Angeles finds).

Participants at expert meetings in San Diego and Miami generally considered this a moderate-risk Medfly pathway for their areas and identified Latin America as the most likely source. Participants in Los Angeles rated cargo predominately from Latin America as high risk. Hawaiian participants rated cargo from Hawaii as a high risk pathway.

(14) Pathways through Canada

Canadian plant protection regulations do not restrict the entry of foreign fruits because tropical and subtropical fruit flies including Medfly would not become permanently established in a northern climate. Large volumes of Medfly host material is imported into Canada from various countries and Hawaii.

The most important pathway for Medfly-infested fruit entering the United States from Canada includes: (1) commercial lots, mismanifested or undeclared, moving as cargo; (2) in aircraft stores; and (3) in the baggage of car, train, bus, or plane travelers.

(a) Cargo

In 1987 and 1988, PPQ conducted Operation ICE, Intensified Commercial Enforcement (Hall, 1988). The objective of Operation ICE was to improve commercial shipper's compliance with APHIS regulations at the Canadian border and to gather information to define the staffing needs at specific locations at the Canadian border. The program was implemented because of a growing belief that numerous shipments of restricted and prohibited products were entering at Canadian ports. At 32 Canadian border locations PPQ

Officers performed a series of blitz inspections of commercial carriers. A total of 14,138 commercial carriers and their cargo was inspected. PPQ targeted agricultural cargo, refrigerated trucks, international sea containers, and Customs line release cargo. These inspections excluded regulated cargo normally covered by PPQ. A total of 59 significant irregularities were found that included restricted or prohibited products. The irregularities consisted of either improper manifests or outright smuggling. In one shipment approximately 300 boxes of Korean sand pears (not a Medfly country) were found hidden under a load of Canadian-produced oriental vegetables. Several other shipments contained vegetables manifested either as U.S. or Canadian origin but were from a third country, or manifested as Canadian, but originated in Hawaii.

(b) Aircraft Stores

The 1985 Canadian Border Evaluation found that some flights of Canadian origin are catered with whole fruits from various foreign countries. The risk from stores would still be relatively low. The most common fruits found in aircraft stores would include apples, pears, grapes, bananas, and oranges. Many of them were of U.S. or Canadian origin, from Chile's Medfly-free area, or high quality European fruit.

(c) Travelers Baggage

Travelers entering the United States from Canada may possess fruit fly host material originating from a Medfly country or Hawaii by two methods. First, the traveler may obtain the fruits from a retail outlet in Canada. As stated above, Canada does not restrict the movement of fruits because of tropical or subtropical fruit flies. In 1985, PPQ visitors to several outlets in various Canadian locations indicated that a wide range of Medfly hosts is available originating from areas where Medfly occurs. These include apples from South Africa, France, and Australia; oranges from Italy, Israel, and Morocco; figs from Brazil, Spain, and Italy; cherimoya from Peru; grapes from Brazil, Spain, and Italy; guavas from Brazil; tangerines from Peru; mangoes from Brazil, Venezuela, Peru, and Hawaii; pears from Australia; peppers from Spain; persimmons from Brazil; and star fruit from Brazil. The travelers move by car, plane, bus, or train. Most of these travelers were residents of either Canada or the United States. The 1985 evaluation indicated that 18 percent of the vehicles or passengers found with prohibited agricultural products were destined to high risk locations (Florida, California, Texas, or

other southern states). These travelers are subject to U.S. Customs inspection but few vehicles or baggage of passengers are inspected. Several factors help limit the risk of this pathway.

- Many travelers enroute to southern States by car eat the fruit in transit.
- The most common fruits obtained in Canadian stores and taken south are of no risk for Medfly (originating in non-Medfly countries such as Canada, United States, or Chile) or limited risk (export quality fruits from Europe, Australia, and South Africa).
- Travelers from Canada destined to California are subject to CDFA inspection at the California Border.

Although the risk is limited, no doubt a number of U.S. residents obtain certain exotic fruits in Canada that are unavailable back home in the United States. The exotic fruits such as cherimoya, guava, and mango, from Latin America are more likely to be infested with fruit fly than oranges from Italy or apples from France.

The second way travelers entering the United States from Canada may posses fruit fly infested material is that they are transiting Canada from other countries or Hawaii. The 1985 evaluation indicated that substantial numbers of people arrive in Canada by plane (mainly at international airports in Vancouver, Montreal, and Toronto) and then continue their travels into the United States by plane or ground transportation including their own cars. There are flights into Canada that originate from areas where Medfly occurs including Southern Europe and Latin America. The travelers would be subject to U.S. Customs border clearance. The evaluation also indicated that a small portion of these travelers were destined to high risk southern states. Some of the risk is reduced by state agricultural inspection at the California border. Although this situation poses some risk, it would be small compared with the risk posed by the six million plus people that arrive to the United States annually directly from Medfly infested countries. Participants at the various expert meetings generally considered the pathway through Canada as either low risk or low to moderate risk.

(15) Pathways Through Mexico

The risk of Medfly entering the United States via Mexico is small. Medfly is not known to be established in Mexico although frequent infestations are found and eradicated in southern Mexico near the Guatemalan border. Various potential pathways are assessed below.

(a) Cargo from Third Countries

Mexico prohibits the importation of Medfly hosts from areas where Medfly occurs. In fact, Mexico imports only a small amount of fruits and vegetables from countries other than the United States. Because of the large variety of fruits grown in Mexico and thus available in the market, there is little incentive to smuggle fruit shipments into Mexico. Only one report of fruit shipments from a third country arriving in the United States via Mexico was found during this assessment.

(b) Travelers Baggage

There is a potential risk for Medfly introduction from infested fruit carried into the United States via Mexico by travelers from a third country. The risk would be greatest from Central America. The travelers would enter at the land border crossings or by air (for those that enter by air, the risk is assessed under pathway 1).

Of the approximately 220 million people per year that legally cross the U.S./Mexican border, a small percentage is from third countries commonly from Central America. About seven percent of the vehicles are referred to secondary inspection by Customs, Immigration, or PPQ. Most campers, vehicles that have traveled to the interior, and vehicles containing luggage, boxes, and groceries are routinely referred to secondary inspection. Luggage and groceries carried by pedestrians and bus passengers are almost always inspected.

In addition to the millions of people that legally cross the border, hundreds of thousands of illegal aliens cross the Mexican border each year. Many of them cross the border in the San Diego area. The number of apprehensions of illegal aliens from all of the U.S./Mexican border was about 1.2 million in 1985, 1.6 million in 1986, 1.1 million in 1987, and 0.9 million in 1988. In FY 1985, 427,772 deportable aliens were apprehended in the San Diego Border Patrol sector. All but 2.17 percent of these were Mexican. The number of illegal aliens crossing the border and not captured is unknown, but it is assumed to be very large. Of the 9,288 (2.17 percent) who were not Mexican, the majority (78 percent) were from Central American countries where Medfly occurs; Costa Rica (40 deported aliens), El Salvador (3,704), Guatemala (2,446), Honduras (399), Nicaragua (609), and Panama (11). Many of the illegal aliens crossing the border at areas other than border stations carry food

with them. The Border Patrol collects and holds this food (including fruit) for PPQ and CDFA personnel. An estimated 12,000 pounds of food is collected each year at two of the five Border Patrol stations in San Diego area. In recent years, fruit from these two station was found to be infested by CDFA personnel, once with Anastrepha ludens and once with Anastrepha obliqua. Opinions differ as to whether the fruit carried by illegal aliens from Central America may have originated from Central America.

(c) IS/Mexican Activities that Reduce Risk

There are a number of program activities within Mexico where IS works with the Mexican Government that reduces the risk of introduction of Medfly into the United States.

One activity is the restrictions on Medfly host material grown in the State of Chiapas. Medfly infestations occur periodically in Chiapas because of it's close proximity to Guatemala. Commercial lots of Medfly host material from Chiapas must be treated for Medfly if shipped to other parts of Mexico, thus reducing the risk from undetected Medfly populations in other parts of Mexico.

A second activity is an exotic fruit fly detection program that is conducted in key fruit producing States of Mexico. Medfly is one of the target species thus again reducing the risk from an undetected Medfly population.

Thirdly, there is the fruit fly exclusion activities in Sonora and Baja, California. The major objective is to keep Sonora and Baja, California Norte free of pest species of fruit flies. These activities include maintaining quarantines at road stations into this area. Commercial lots of host commodities are treated and vehicles are inspected for prohibited fruits. Similarly passengers are cleared at the Tijuana International Airport. The major purpose of this operation is to stop movement of Anastrepha-pest species. All scheduled flights arriving in Tijuana originate from other locations in Mexico. Passengers from Central America arrive via other Mexican airports. IS records show that in 1988, a total of 5,142 planes arrived with 750,646 passengers from various Mexican locations and that 1,621,972 pieces of baggage were cleared. From this baggage, 10,932 units (2,496 kg) of fruit were seized and 1,638 Anastrepha larvae were found in this fruit. A small percent of the fruit seized originated from Medfly-infested countries such as El Salvador and Guatemala. Medfly larvae have not been found in fruit seized at the

airport. Because of a lack of Medfly interceptions from this operation, it can be assumed that the risk of Medfly from this pathway to southern California is currently minimal. Assuming that a small amount of Medfly infested fruit moves through the airport, it would have to: (1) also go undetected at U.S. border port operations before it could cause an infestation in California, (2) be carried across the border by illegal aliens and then cause an infestation in California or (3) cause an infestation in northwestern Mexico and go undetected for a period of time.

Participants at the expert meeting in Miami generally considered the pathways via Mexico as low. Participants from Los Angeles and San Diego generally rated this pathway as moderate risk. The assessor rates the overall risk as low. The risk to most U.S. areas including California and Florida appears minimal. The one exception where the risk is estimated as higher is the Rio Grande Valley in Texas. At least for a large portion of the year oranges and grapefruits are available. The area would be a common entry point for people traveling overland (or by air to a Mexican airport and then overland) from Central America to the United States. This area lacks the additional safeguard that exists for California because of the Sonora and Baja California quarantine activities. This was a possible pathway for the 1966 Brownsville, Texas, Medfly infestation.

(16) Commercial Shipments of Live Animals

Whole or cut fruits are known to arrive with commercial shipments of live animals (mainly primates and pet birds). PPQ Officers greet the arrival of shipments of primates and collect any fresh fruit found with these shipments.

Shipments of commercial birds imported into the United States must be quarantined for at least 30 days at a VS or privately-owned commercial facility approved by VS. The Miami Animal Import Center, the VS Facility located at the Miami International Airport was visited as part of this project. At this facility all material including fruit was removed from the import cages on arrival and incinerated. This operation poses little or no risk for Medfly.

There are currently 60 privately-owned commercial bird quarantine facilities in the U.S. located near designated ports of entry. These facilities are approved and maintained under the supervision of VS. Most are located in the Miami area (22 facilities) and in California.

(25 facilities) (Suguiyama, 1990). In addition, one facility is located in Hawaii, 3 in Texas, and the others at northern locations. Several facilities were visited in the Miami area. All material including fruit is removed and bagged from shipping containers after the arrival of imported birds. This bagged material and any other waste material is kept in quarantine with the birds for 30 or more days. The safeguards and the security at these plants are such that little risk from Medfly occurs. In Florida, at the end of the quarantine period waste, including any exotic fruit, is destroyed. If the birds fail the quarantine, the waste material is incinerated at the VS Import Center, but if the birds are released, then the waste is taken, under the supervision of VS, to a Miami City public facility for incineration. The bagged waste material may not get incinerated for several days. The risk for this fruit would not be great, but this is an area where additional safeguards could be used. This pathway was identified during the December 1987, California pathway meeting and action was taken to eliminate the risk for California.

How common are shipments of commercial birds that arrive with fruit? In 1989, 285 commercial shipments of birds arrived in the United States: 94 in California, 150 in Florida, four in Hawaii, five in Texas, and the others at northern locations. Only the fruit-feeding birds such as parrots would arrive with fruit. Fruit is shipped with these birds more as a source of moisture than for its food value. Currently, many shipments arrive with wet sponges nailed to the bottom of the cages in place of fruit. An unknown but relatively small number of shipments arrive with fruit.

(17) Adults Not Associated With Host Material

The risk of Medfly becoming established from adults hitchhiking on or in airplanes, ships, cars, trucks, or within cargo containers carried by airplanes, ships, or trucks appears to be low.

The only record found during this assessment of an adult Medfly being intercepted on an aircraft was a 1960 report of one adult found in a cargo plane in Hawaii. The oriental fruit fly has been more closely associated with this pathway. During a population peak (1948-1965) after oriental fruit fly became established in Hawaii, 134 adult flies were intercepted during the inspection of 119,932 planes departing Hawaii for the U.S. mainland. Since that time, the interception of oriental fruit fly adults on planes leaving Hawaii has become a rare event (Mitchell, 1977). In a 1984 evaluation in Hilo, Hawaii, even

though 80,000 oriental fruit flies were trapped around the airport in a 15-day period, none were found in an aircraft (Carter, 1984).

At or around the Hawaiian airports in Lihue (Kauai), Hilo (Hawaii), and Honolulu (Oahu) trapping has been conducted by either PPQ or ARS, but Medfly has not been captured or only rarely captured. The assessment found no trapping reports for the airport in Kona, Hawaii. Kona Airport has direct flights to California, high populations of Medfly occur in the coffee belt above the Kona Airport and tropical almond trees are located near the airport; thus some risk may occur at this location from adult hitchhikers. In Central America, host plants and possibly Medfly are found at or near most of the international and military airports, not including the airport in Guatemala City (Per com. Pat Gomes, IS, 1992). The occurrence of Medflies around airports in Europe and South America was not assessed.

Even if adults manage to hitchhike in the passengers compartments or cargo area of aircraft, the risk that they will successfully establish is limited. Medflies are weak fliers. The airport environs is generally hostile. Even if several flies hitchhike within the same aircraft, the probability of any of them finding a mate after departing the aircraft is remote. The normal method for finding mates is for the males to form leks (small groups) to attract females. If the lek size is too small then the chances of attracting the female would be small (Carey, 1982).

The possibility of a mated female hitchhiking on an aircraft and later finding suitable host fruits in or near a southern U.S. airport does exist, but it would be small.

The risk of Medfly establishing in the United States from adults hitchhiking in cars or trucks is very remote. Although the movement of adult flies within cars and trucks is feasible as indicated by sterile Medfly finds hundreds of miles from the release area during the 1987 Los Angeles infestation, the probability of Medfly moving from the Mexican/Guatemalan border by this pathway would be low (CDFA, 1987). No evidence was found of adult flies hitchhiking with ships or within cargo containers carried by planes, ships, or trucks.

E. Pathway Risk Summary

Given below is a summary of the various pathways identified for Medfly and an estimate of the risk. Risk here is defined as the likelihood of entry of the pest under the current operational and regulatory safeguards maintained by APHIS; the likelihood that Medfly would become established from this entry; and the impact if Medfly become established. The impact if Medfly becomes established for all pathways is assumed to be the same for these estimates although this may not be true. PPQ's ability to quickly detect and eradicate a Medfly infestation probably varies from location to location, thus the impact (cost of eradication) would vary.

TABLE 3 - RISK LEVEL ESTIMATES

PATHWAY	HIGH	MODERATE	LOW
1. Passenger and crew baggage from foreign (airport)	At Los Angeles, San Francisco, and Miami	At airports with a large percent of transits to FL and CA. At Houston, Dallas, New Orleans, other FL and other CA airports.	At all others
2. Passenger and crew baggage from Hawaii (airport).		All HI airports, possible high in Kona and Maui during Medfly population peaks.	
3. Aircraft (stores, quarters, holds, and garbage)		All FL and CA ports and from HI to CA ports	All others
4. Domestic mail from Hawaii		To all far southern States	
5. Foreign Mail		At Los Angeles, San Francisco, and Miami	At all others
6. Express Mail Carriers from foreign			All probably low
7. Express carriers from HI	To CA	To other far southern States	To all other states
8. Cargo ships (stores, quarters, baggage, and garbage)	At FL ports from Central America		
9. Cruise ships (stores, quarters, garbage and baggage)			All
10. Yachts (stores, quarters, garbage, and baggage)			all probably low
11. Naval ships (stores, quarters, garbage, and crews)		San Diego - moderate to low	All others

TABLE 3 - RISK LEVEL ESTIMATES (CONTINUED)

PATHWAY	HIGH	MODERATE	LOW
12. Fishing ships (stores, quarters, garbage, and crews)		FL ports from Central America	All others
13. Cargo	At Los Angeles, San Francisco, and Miami; from Hawaii to California	Other CA and FL ports	All others
14. Pathways through Canada			All
15. Pathways through Mexico		Lower Rio Grande Valley ports	All others
16. commercial shipments of live animals			All
17. Adult Medflies not associated with host material			All

F. Immigration Trends

Changes in immigration patterns can have a significant impact on the risk of Medfly introductions, both in the frequency and location of infestations. Newly settled immigrants in the United States from an area where Medfly occurs pose a significant risk. The new immigrants tend to visit or be visited by people from the original locations. They are likely to have a penchant for tropical fruits which are not readily available in the United States and high risk backyard fruits from their "old" home area are easily available. They also can help create a market for the importation of commercial lots of illegal fruits. The greater the number of these immigrants that settle within areas that Medfly can colonize, the greater the risk. Those areas that have a large number of newly arrived immigrants from areas where Medfly occurs are the same areas that have experienced repeated introductions of Medfly.

(1) Changes in Immigration Patterns over Time

Since the early 1960's, there has been a drastic shift in U.S. immigration patterns away from Europe to Latin American and Asia. Currently about 90 percent of the new arrivals are from Latin America or Asia. Table 4 shows the number (or average number) of immigrants arriving into the United States from all countries and from the important Medfly areas from 1961 to 1986. Note the increase for selected Central American countries, the decrease for high risk areas in Europe, and the overall increase for all countries.

Table 4 - Changes in Immigration Patterns by Country of Birth (in thousands)

Selected Countries	1961 - 1970 Average/Yr	1971 - 1980 Average/Yr	1981 - 1985 Average/Yr	1986
Central America El Salvador, Guatemala, Nicaragua, and Panama	5.9	9.6	18.5	21.1
Europe Italy, Portugal, Spain, and Turkey	32.3	28.3	11.6	10.3
Total for all Countries	332.2	449.3	572.9	601.71[1]

[1] The majority of the 1986 immigrants are from non-Medfly areas; e.g. Asia (268,200), Mexico (66,500), and Caribbean (101,600).

Source: Statistics Division, U.S. Immigration and Naturalization Service

(2) Immigration Patterns into High Risk States

Over 40 percent of the new immigrants arriving into the United States intend to reside in California, Florida, or Texas. Over a third of the people arriving from Central America, Asia, or Oceania intend to settle in California. The two most common countries of birth from Asia are the Philippines (first) and Vietnam (second). The first and second States of intended residence of people from the Philippines are California and Hawaii, and large numbers of the people of Vietnamese birth settle into those same States; thus setting up for years a high risk situation for Medfly and other fruit flies in Hawaii for California. (See Table 5). In Florida, a large percent of new arrivals are from Latin America.

Table 5 - Immigration into the United States by Area of Birth (FY 1989)

		State of Intended Residence (Percent)			
Area of Birth	U.S. Total (thousands)	California	Florida	Texas	Others
Europe	73.6	20.0%	4.6%	2.7%	72.5%
Asia	280.1	37.8	2.0	4.3	55.9
Africa	18.4	17.4	3.3	7.6	71.7
Oceania	3.9	45.1	21.0	2.6	31.3
North America[1]	156.5	23.4	10.3	12.5	53.8
Central America	33.9	37.5	10.6	4.7	47.2
South America	44.7	10.3	12.1	2.2	75.4
TOTAL	612.0	29.6	5.7	6.2	58.5

[1] Canada, Mexico, and the Caribbean

(3) Immigration Reform and Control Act of 1986

The Immigration Reform and Control Act of 1986 made two groups of illegal aliens who had lived or worked in the United States eligible for legal permanent residence. One group (group 1) is aliens who have been in the United States unlawfully since 1982 and the second group is aliens who were employed in seasonal agricultural work for a minimum of 90 days between May 1985 and May 1986. As of November 2, 1989, 3.1 million illegal aliens applied for legal residence under the provisions of this act. A majority of these people reside in high risk areas in the United States for fruit flies and large numbers are from countries where Medfly occurs (Hoefer, 1990). Table 6 indicates the percentage arriving from Medfly countries, the percentage living in high risk States, and the metropolitan area where they live. Note the very large percentage residing in California and the high percentage given for the Metropolitan areas of Los Angeles - Long Beach.

(4) New Immigration Legislation

November 19, 1990, President Bush signed a comprehensive revision of the U.S. Immigration law. The new law took effect October 1991, and will allow legal immigration to climb from about 500,000 to about 700,000 people per year for the first three years; and then establish a permanent level of 675,000 per year. It has special provisions to increase immigration for European and specially trained workers, but the largest allotment of visas will remain for family-sponsored immigration (Biskupic, 1990). The net result of this will probably be 40 percent increase of immigration per year. Most of these people will be from fruit fly-infested areas in Latin America and Asia, and about half of them will settle in areas within the United States that are high risk for fruit flies. The majority will settle in metropolitan areas and many of these well settle in Southern California, specifically in the Los Angeles area.

Table 6 - Alien Applicants under the Immigration Reform and Control Act of 1986		
	Group 1 Illegal Residence Since 1982 (Total 1.77 million) Percent of Total	Group 2 Seasonal Agri. Workers (Total 1.3 million) Percent of Total
Country of Citizenship		
Mexico	69.9	81.7
Medfly Countries	16.9	3.1
ALL OTHERS	13.2	15.2
State of Residence		
California	54.5	53.4
Texas	17.7	9.9
Florida	2.8	9.0
Arizona	1.6	4.3
ALL OTHERS	23.4	23.4
Metropolitan Area of Residence		
Los Angeles - Long Beach, CA	35.0	Not Available
Anaheim - Santa Ana, CA	5.0	
Riverside - San Bernadino, CA	2.7	
San Diego, CA	2.3	
San Jose, CA	1.5	
San Francisco, CA	1.3	
Houston, TX	6.0	
San Antonio, TX	1.0	
McAllen, TX	1.0	
Miami - Hialeah, FL	1.7	
Phoenix, AZ	1.0	
ALL OTHERS	41.4	

G. Profiling Methods within PPQ

For a number of years PPQ has used passenger profiles in the clearance of air passengers from foreign countries. The passenger profile describes characteristics that can be used to predict whether a person may be carrying agricultural contraband. These characteristics include general appearances, age and relationship to other passengers, types of luggage, and declared reason for travel. By this method they identify high risk agricultural flights and determine which passengers to send to secondary inspection. The profiles were developed from information at least in part gathered in a year-long survey conducted at six major international airports. In general, this profile has served PPQ well. The one shortcoming of this profile method is that the passengers are judged low or high risk based only on the probability of them carrying agricultural contraband. No consideration is given to the seriousness of the pest that may be carried in the contraband, nor the probable destination of the passenger and the likelihood that the pest will become established there.

The current system appears to work well with most western and south central region airports but may not with eastern U.S. airports with a large portion of passengers from the West Indies. Two examples of this are given below:

At JFK International Airport in New York, the officers and the profile guidelines consider flights from Jamaica, Dominican Republic, and Haiti as high risk and a large number of passengers from these flights profile as high risk. In fact, a large number of the passengers from these flights do carry contraband but the actual pest risk from the contraband is low. This risk is low because:

- There are relatively few quarantine pests in the West Indies.
- Most of the pests attack minor crops.
- Most of these pests are tropical and would not become established in the northern United States and the large majority of the passengers landing at New York from the West Indies would be destined to northern locations.

Officers at New York could protect agriculture better if they spent more time inspecting baggage from "lower risk passengers" from northern Europe. They would find fewer prohibited baggage lots, but these could be infested which pests that are more serious than those from the West Indies and are more likely to be a threat to our more northern crops.

The second example is in Miami which also receives a large portion of its passengers from the West Indies and which they consider as high risk. Again the actual pest risk is low because:

- Few quarantine pests occur in the West Indies and many of these already occur in Florida.
- Most of the pests attack minor crops.
- The large majority of the passengers landing in Florida are destined to either northern areas or the southeastern United States; therefore, most of the pests would not become established or are already established.

Officers in Miami would be protecting agriculture better if they spent more time inspecting baggage of "lower risk passengers" from South America where many serious agriculture pests occur including Medfly.

H. Results and Possibilities of Fingerprinting

In the late 1970's and early 1980's, M.D. Huettel, Research Entomologist, ARS, made electrophoretic comparisons of the allele frequencies of Medfly populations throughout the world. The comparisons indicated a large reduction in genetic diversity of the immigrant populations. With this information he could show the probable distribution pattern of Medfly. Dr. Huettel compared specimens from the 1980 California (San Jose area) infestation with the various world Medfly populations. He concluded that this infestation did not originate from Hawaii and could have originated from Latin America (Calkins, 1983).

Arrangements were made at the start of this assessment to have infested fruit sent from new U.S. Medfly infestations and to have the larvae reared to adults at Beltsville, Maryland, by PPQ. ARS researchers could then make the electrophoretic comparisons of various enzymes to hopefully determine the origin of the new infestations.

During the 1989 Los Angeles infestations infested fruits were sent to Beltsville. One larva from Elysian Park and about 85 larvae from the Whittier area were reared out to adults. Later an additional fly from the 1990 Florida infestation was sent to ARS in Beltsville. In November 1989 and May 1990, electrophoretic gels were run using some of the California flies. No definitive information was gained from either set of gels. The most potentially helpful enzyme was one called Acontase-2, which was variable for the California sample. This enzyme was not used during the original research, therefore the variability of this enzyme for the various Medfly populations around the world is unknown. A few wild flies tested in May 1990, from Hawaii and Latin America showed no variability for Acontase-2, but the number tested were too few.

To determine the possible origin of the California infestation by this method at least several hundred flies from various locations will need to be tested. Other research entomologists are pursuing the possibility of using a DNA technique. They are looking at variability in mitochondrial DNA using RFLB. Dr. Mike Haymer, University of Hawaii, is researching the possibility of using another DNA technique. He is using viral props to identify variations in the nuclear DNA.

Each of the three techniques has advantages and disadvantages, and none should be discouraged at this time. In the future we should be able to determine or help determine:

- The origin of Medfly infestations.
- The possibility of a current infestation originating from a previous infestation that was thought to be eradicated.
- An additional method of determining a wild fly from a sterile fly.
- If a fly found in a trap was a "plant".

(1) Seasonal Variation in the Continental United States

Of the 32 detections of Medfly in the continental United States since 1929, eighteen represented infestations resulting in USDA and State officials initiated eradication programs. In 14 other cases, one or two adult Medflies were captured. Trapping was intensified and after no other flies were captured it was determined no infestations existed. The purpose of this section is to evaluate the seasonal variation of Medfly detection in the continental United States and to examine possible factors affecting this variation (Miller, 1990). These factors include climate and host phenology at California and Florida locations (which could effect Medfly colonization potential in different seasons) and the seasonal variation in movement of infested plant material from areas where Medfly occurs.

Seasonal distribution of Medfly infestations (in the month first detected) is compared to the seasonal distribution of one- and two-fly captures (Figure 2 and 3). The calendar year was divided into two 6-month periods: April-September (warm season) and October-March (cold season). Nine infestations occurred in Florida (eight in the Miami area, one in Tampa), eight infestations occurred in California (six in Los Angeles, two in Santa Clara), and a single infestation occurred in Brownsville, Texas. Where one or two flies were captured, half occurred in Florida, half in California. The 1929 and 1956 Florida infestations are not included because no detection program existed, thus the infestations could have begun months before detection.

Climate and host phenology for Miami and Los Angeles (Campbell, 1987 and Harnett, 1988) are evaluated to determine possible influence on seasonal variation of infestations. It is assumed that seasonal absence of host fruit or unfavorable temperature for Medfly development would greatly reduce colonization potential. Minimum, maximum, and optimal temperatures for Medfly development are identified from the literature (Worner, 1988) and compared to average monthly temperatures in Los Angeles and Miami. USDA Medfly interception records for all United States ports of entry and at predeparture in Hawaii are divided into regional groups of origin: Old World (Europe, Near East, and Africa); Latin America (South and Central America); and Hawaii. The monthly distribution of interceptions from these regions is compared with Medfly occurrences (both infestations and noninfestations) in Florida.

FIGURE 2

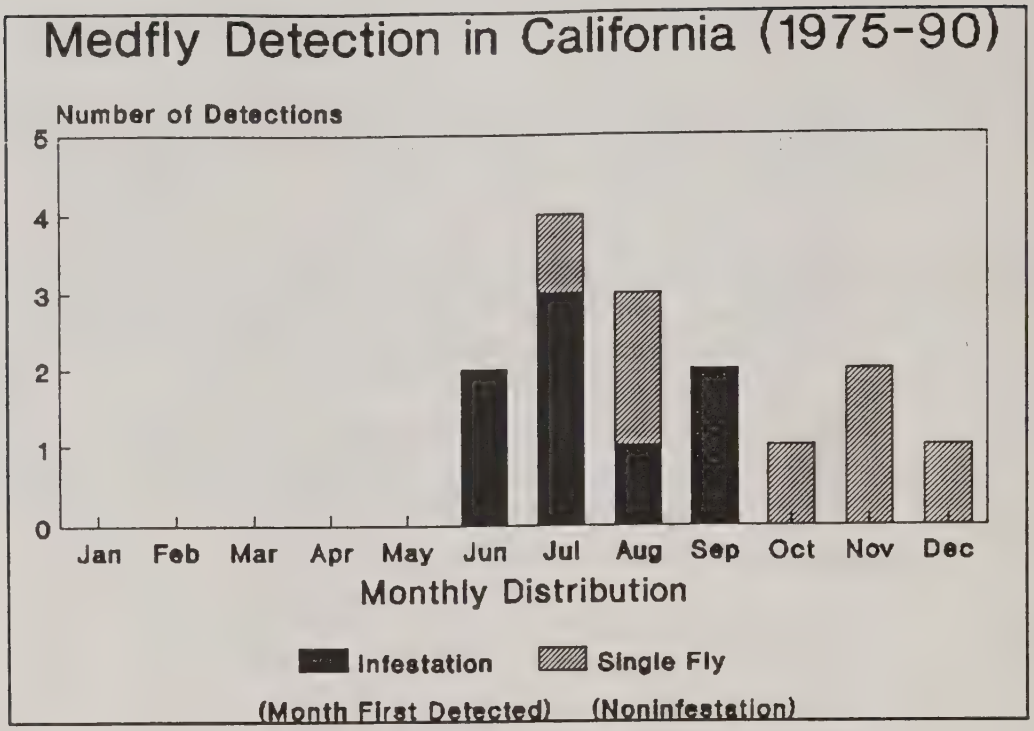


FIGURE 3

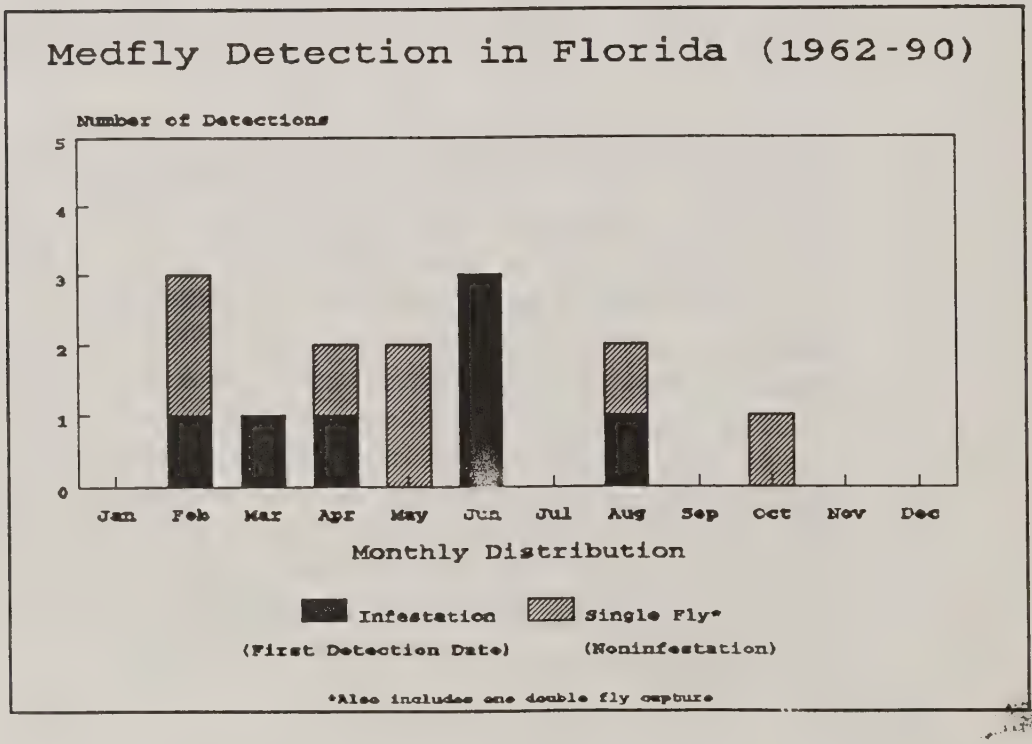


Table 7. Probability of Results Not Differing from Randomness

MONTHS	INFESTATION	NONINFESTATION	SUM	PROBABILITY
CALIFORNIA				
Apr.-Sept.	8	3	11	
Oct.-Mar.	0	4	4	
Sum	8	7	15	0.0256
FLORIDA				
Apr.-Sept.	5	4	9	
Oct.-Mar.	2	3	5	
Sum	7	7	14	0.3671

Infestations vs. non-infestations: For California, the seasonal difference for the likelihood of infestations versus single-fly catches was significant (P=0.026) using Fisher's exact probability test (Table 7) (McGuire *et al.*, 1967). Because there is a 97.4 percent likelihood that the absence of infestations, but not single-fly finds, during the colder months of the year is not due to random chance, the absence can probably be attributed in part to low colonization potential in California from fall to spring. There was no significant difference in the seasonal distribution of infestations compared with one- and two-fly captures in Florida.

Influence of Climate and Host Phenology: The average monthly temperatures--maximum, mean, minimum--for Los Angeles and Miami (Figure 4 and 5) are compared to threshold temperatures for Medfly development (upper 33 C, lower 16 C) and optimal temperature for Medfly development (22.2 C to 30.8 C). Analysis of these data suggest Miami is a far more favorable environment for Medfly than the Los Angeles area. The average mean monthly temperatures in Los Angeles were below optimal levels for Medfly development all year, and the average mean monthly temperatures were below the minimum temperature for development 5 months a year. Average mean monthly temperatures for Miami are in the optimal range 8 months a year and above the minimum temperature for development all year.

Commercial and backyard host fruits are abundant year-round in the Los Angeles and Miami areas (L.A. County, Dade County, and adjacent counties). Commercial plantings of preferred hosts in the Los Angeles area include apple, apricot, peach, pear, prune, fig, and orange. Infested backyard fruits found in the 1989 Los Angeles infestation include peach, strawberry guava, calamondin, orange, kumquat, fig, and persimmon. The preferred hosts grown commercially in southern Florida include guava, mango, and orange. The various tropical fruits

grown in backyards in southern Florida include such preferred Medfly hosts as akee, guava, kumquat, loquat, mango, sour orange, star apple, Surinam cherry, grapefruit, tangerine, and orange. Most of the available host material during the winter and spring in both locations are citrus fruits; a large variety of hosts are available in summer and fall.

Pest Interceptions Compared to United States Detections:
Interceptions from Hawaii and the Old World are much more frequent in the last 6 months of the year. Interceptions from Latin America are most frequent in the first 6 months of the year. Figure 6 shows the seasonal distribution of Medfly interceptions from each region (percentage by month). The number of interceptions per region varies greatly: 343 interceptions from the Old World (1984-1989), 16 from Latin America (1984-1989), and 705 from Hawaii (1970-1987). The distributions of interceptions from the Old World and Hawaii are significantly different from the seasonal distribution of Medfly occurrences in Florida using chi-square. The distributions are also significantly different allowing for a 2-month lag time between movement of infested fruit and subsequent detection of Medflys (see Table 8 for calculations pertaining to Old World; for Hawaii, $p < 10\text{-}5$, and with 2-month lag $p > 0.01$). There is no difference in the seasonal distribution of Latin American interceptions versus Florida infestations, but the number of interceptions is so small that a statistical inference on the amount of correlation (hence possible cause and effect relationship) cannot be drawn on this basis.

FIGURE 4

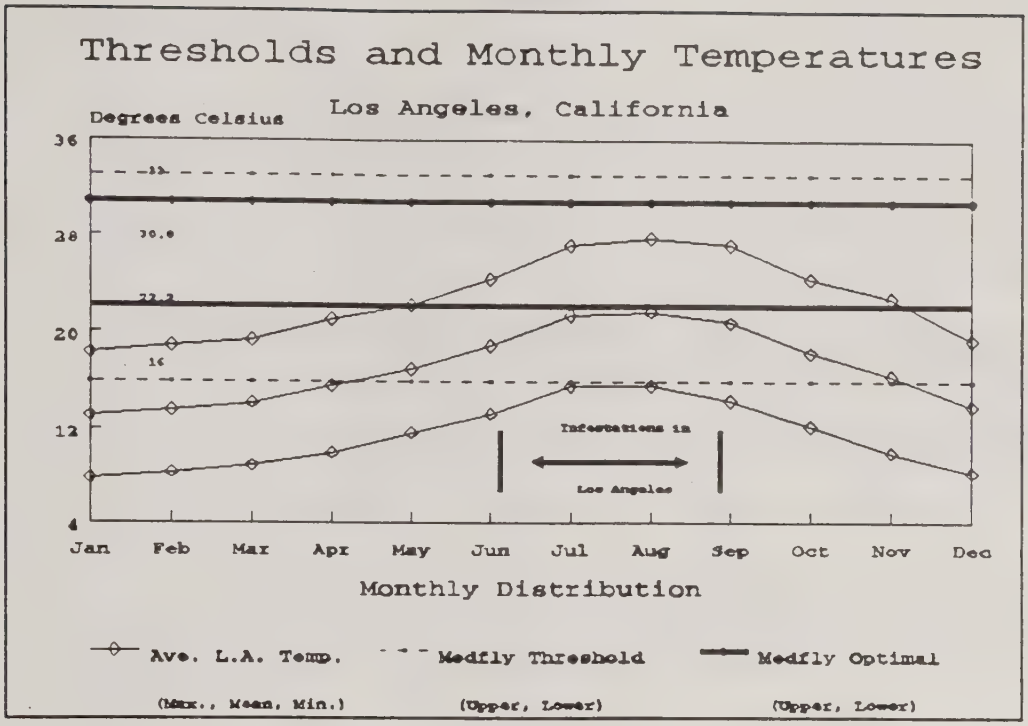


FIGURE 5

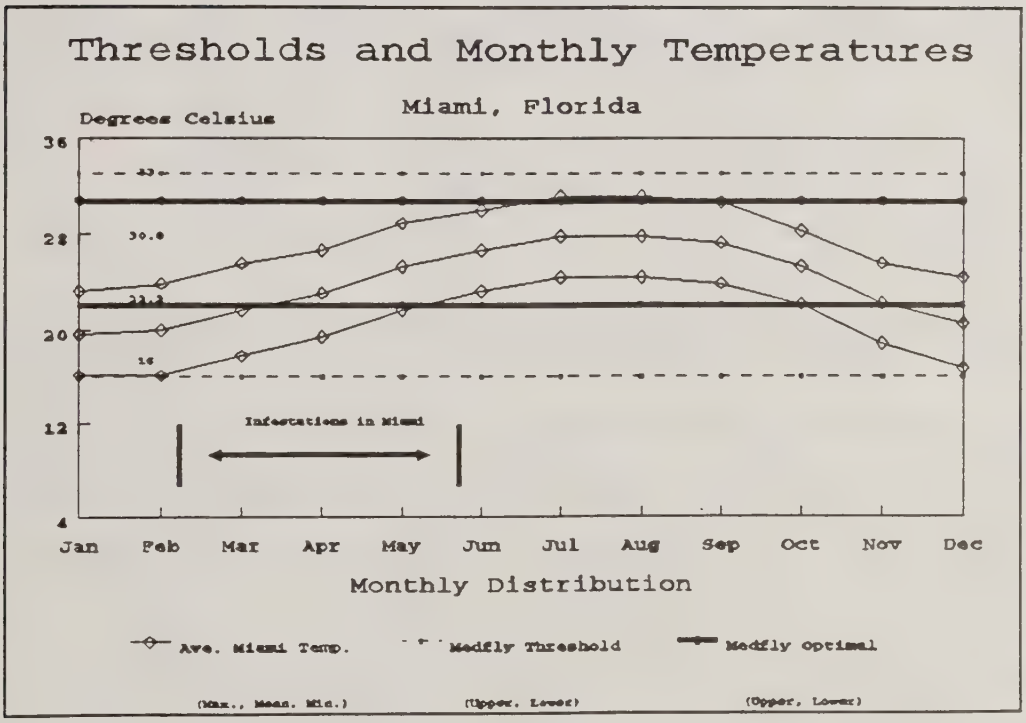
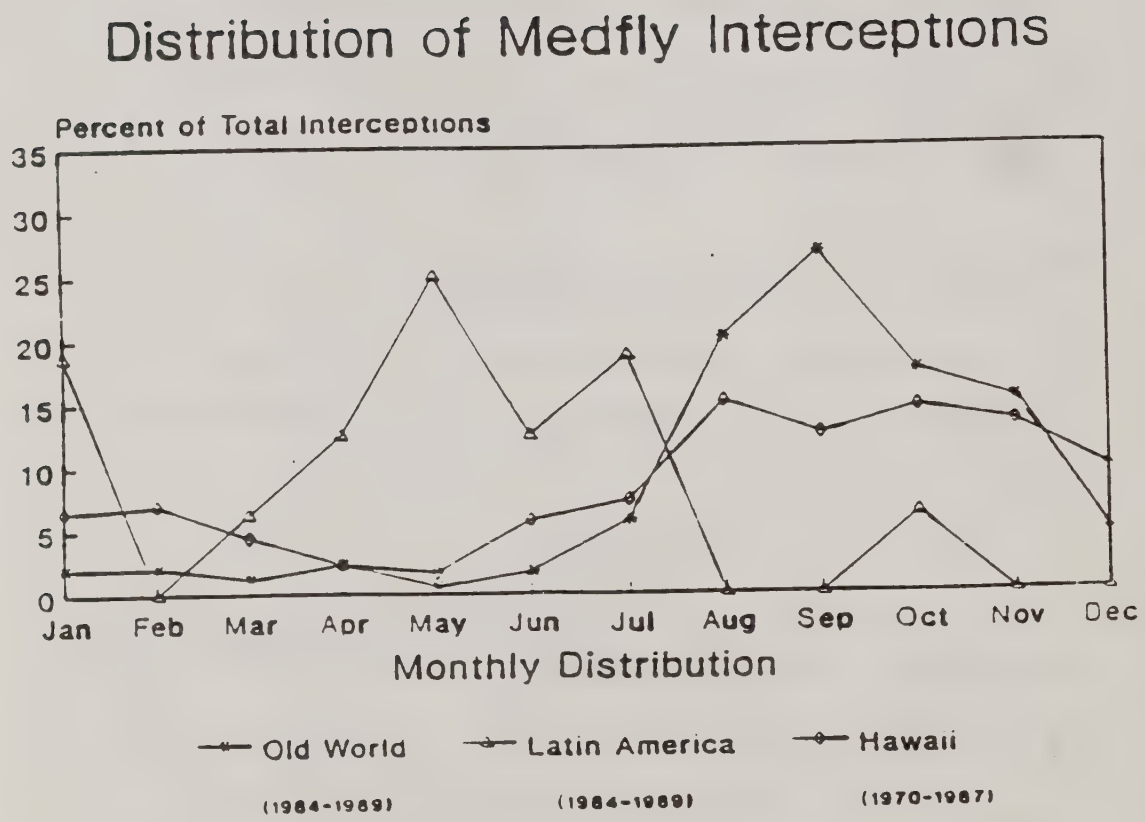


FIGURE 6


Distribution of Medfly Interceptions
Percent of Total Interceptions
35
30
25
20
15
10
5
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Monthly Distribution
Old World
(1984-1989)
Latin America
(1984-1989)
Hawaii
(1970-1987)

FINDINGS

California: The seasonal distribution of infestations compared to that of single-fly captures indicates the colonization potential in California is significantly lower in colder months. The year-long availability of preferred hosts and the comparison of average monthly temperatures with Medfly developmental temperatures strongly suggest the cause of this distribution is temperature-related. Although monthly temperatures for only Los Angeles are compared with Medfly developmental temperatures, the results are similar for other high risk areas (San Diego and Santa Clara Counties). The results suggest quarantine activities, information campaigns, and Medfly trapping should be increased or concentrated in spring and summer.

Table 8. Probability of Results Not Differing From Randomness (Florida Compared to Old World Interceptions)

INTERCEPTIONS - WITH NO LAG		INFESTATIONS - WITH NO LAG		
MONTHS	**NUMBER**	**NUMBER**	**SUM**	**PROB.**
Jan.-June	35	11	46	$< 10^{-9}$
Jul.-Dec.	370	3	373	
Sum	405	14	419	

INTERCEPTIONS - WITH TWO MONTH LAG		INFESTATIONS - WITH NO LAG		
MONTHS	**NUMBER**	**NUMBER**	**SUM**	**PROB.**
Nov.-Apr.	93	11	104	$< 10^{-5}$
May-Oct.	312	3	315	
SUM	405	14	419	

Florida: There was no significant difference in the seasonal distributions of infestations and single- or double-fly captures. In addition, because the findings suggest temperature and host availability are favorable all year in southern Florida, this strongly suggests that colonization potential for Medfly is relatively the same all year.

If the seasonal distribution of Medfly occurrences in Florida is not due to colonization potential, the cause may be attributed to seasonal differences in the volume of infested hosts entering Florida. The seasonal distribution of interceptions by APHIS quarantine activities is used as an indicator of seasonal threat of Medfly from three sources: the Old World, Latin America, and Hawaii. The distribution of interceptions from the Old World and Hawaii is significantly different from Medfly occurrences in Florida, with or without a lag time. If infested fruits from the Old World or Hawaii were the likely sources of Medfly in Florida, then the seasonal distribution of Medfly occurrences should be different.

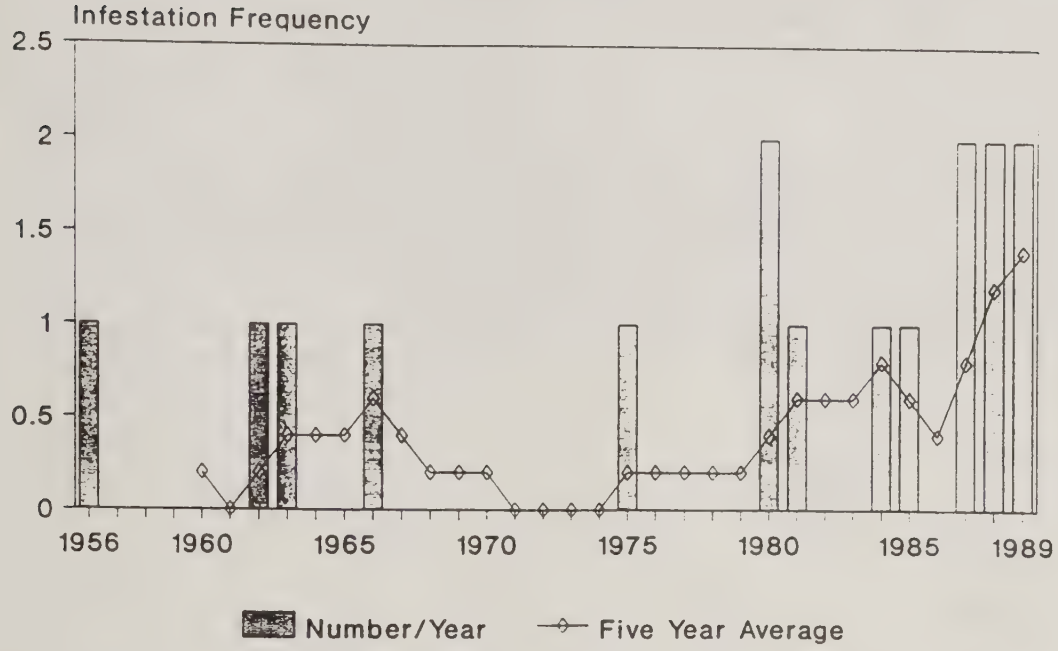
The Latin American interceptions, although few, occur most commonly in the first 6 months of the year, corresponding with seasonal occurrence of Medfly in Florida. The low interception rate from Latin America may be explained by biases between various APHIS work units making pest interceptions. Also, although 95 percent of Medfly interceptions are from passenger baggage, other pathways such as smuggled cargo may be more important to the establishment of Medfly. The results suggest that infested host material from Latin America is more likely than infested host material from the Old World and Hawaii to be the source of Medflies detected in Florida. A similar assessment of the source of Medflies detected in California was conducted, but the results are not helpful because any relationship between occurrences and interceptions is masked by climate.

(2) Annual Frequency of Infestation and Trends Affecting AQI

The frequency of Medfly infestations has increased drastically over the years (Figure 1). Of the 18 infestations in the continental United States, 12 have occurred since 1980. Figure 7 shows the number of infestations per year since 1956. In addition, a 5-year running average is displayed. The 5-year average in 1989 of 1.4 infestations per year is a historic high.

FIGURE 7

Infestations in the Continental U.S.

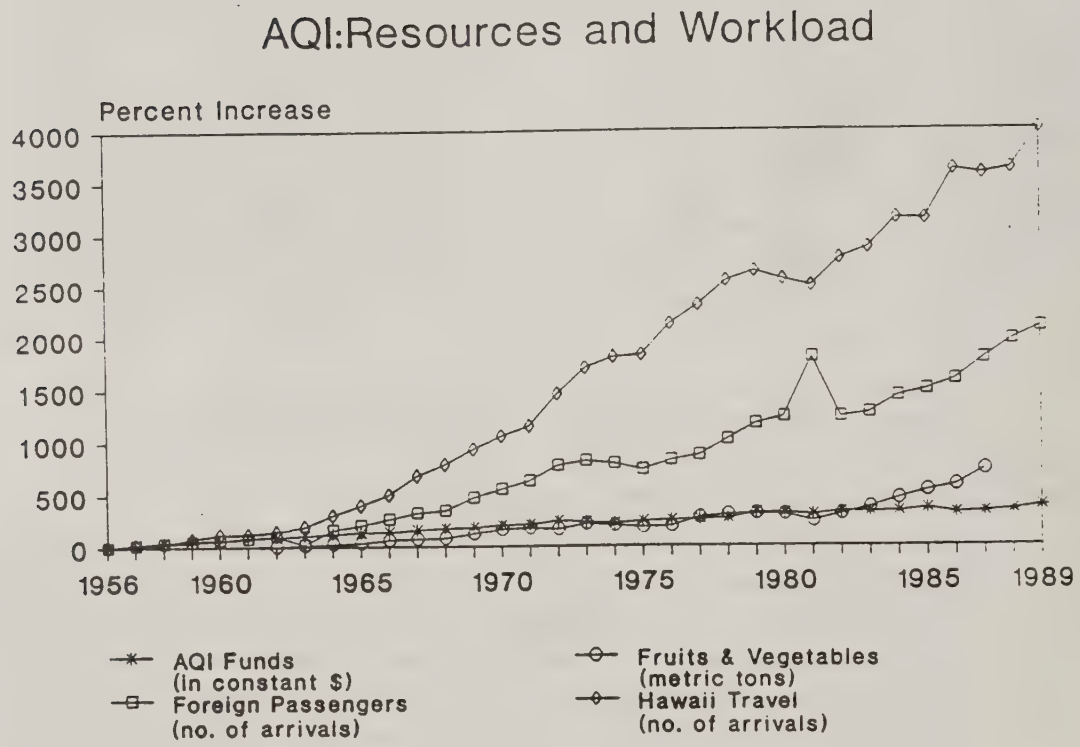


In general, the number of Medfly infestations would be a function of 1) the occurrence of Medfly and the amount of infested host material in foreign countries and Hawaii, and 2) the amount of the host material that is moved into U.S. mainland areas that can be colonized. The occurrence and abundance of the pest has not drastically changed. Medfly did invade Costa Rica in 1955 and then spread throughout most of Central America. On the other hand, in the same time period, the countries bordering the Mediterranean represent less of a threat because of modern pest management programs practiced in those countries for Medfly.

The amount of host material that is moved into the continental United States is related to the number of people traveling, amount of cargo imported, number of ships and planes arriving, and the amount of mail sent; and the AQI programs ability to stop the movement of infested host material. To get a general picture of changes in APHIS's ability to stop the introduction of exotic pests of all kinds, we can compare the increases in AQI resources and the increases in workload. Between 1956 and 1989, there was a 374% increase in the funds used for the AQI program (in constant 1956 dollars). In the same time period the number of travelers (excluding land border crossing and air travel from Canada) has increased from 1.5 million to 33 million people or a

2,081% increase; and travel to and from Hawaii increased from about .1 million per year to 4.7 million or a 4,000% increase. Also, the import of fruits and vegetables in metric tons (minus banana imports) increased from .35 million in 1962 to 2.94 million tons in 1987 or a 726% increase (Figure 8).

FIGURE 8



From 1956 to 1989 several other important changes occurred that would effect PPQ's ability to exclude plant pests. On the negative side are the addition of new responsibilities with no corresponding increase in resources. These include responsibility for animal product imports, noxious weeds, and endangered species. During the same period, U.S. Customs went from a policy of 100% inspection of passenger baggage to a selective system where only a small percentage of the baggage is opened and inspected. Now PPQ has to rely on its own resources to stop the introduction of pests through this important pathway.

On the positive side, three important factors are the introduction and use of X-ray by PPQ, the expansion of international preclearance programs, and the use of detector dog teams.

In conclusion, the AQI workload has increased at a much faster pace than its resources, thus PPQ's ability to stop the introduction of exotic pests in general, and Medfly specifically has been reduced since 1956.

(3) Economic Importance

(a) Eradication Cost

Each time Medfly has invaded the United States, it has been successfully eradicated. The cost of these infestations has ranged from a few hundred thousand dollars to an estimated $200 million. Table 9 shows the cost (unadjusted for inflation) and the cost in 1990 dollars for each infestation. Table 10 show various averages of the cost of these infestations.

Table 9 - Cost of Medfly Infestations		
Infestation	Nominal Cost[1] ($ Millions)	Cost in $ 1990[2] ($ Millions)
FL - 1929	7.5	56.5[3]
FL - 1956	11.0	50.6
FL - 1962	1.0	4.1
FL - 1963	0.3	1.2
TX - 1966	0.37	1.4
CA - 1975	1.0	2.2
CA - 1980 (LA)	0.625	1.0
CA - 1980 (Santa Clara)	200.0[4]	294.0
FL - 1981	1.0	1.4
FL - 1984	1.0	1.2
FL - 1985	2.2	2.6
FL - 1987	1.3	1.5
CA - 1987	2.0	2.2
CA - 1988 (Northridge)	3.357[5]	3.6
CA - 1988 (West LA)	---	---
CA - 1989 (LA)	58.6[6]	58.7
CA - 1989 (Santa Clara)	---	---
FL - 1990	1.8	1.8
TOTAL		484.0

[1] Nominal cost in millions of dollars in given year.
[2] GNP Implicit Price Deflator.
[3] Including eradication costs but not including loss to industry. Since GNP Implicit Price Deflator is not available for 1929, this was estimated from the Consumer Price Index.
[4] About one half of this loss was loss to industry.
[5] This is the total cost for both 1988 California infestations.
[6] This is the total costs for both 1989 California infestations as of September 30, 1990.

Table 10 - Average Cost of Infestations (in $ 1990)	
	Cost in $millions
1. Average cost of infestations (1929-1990)	26.9
2. Average cost of modern infestations (1962-1990)[1]	23.6
3. Average modern infestation cost for FL (1962-1990)	2.0
4. Average modern infestation cost for CA (1975-1990)	45.2
5. Average "early detected" infestation cost when control was chemical only (1963-1990) [2]	1.4
6. Average "early detected" infestation cost when control included sterile flies (1975-1989)	1.8
7. Percent of modern infestations costing $4.1 million or less	87.5%

[1] Modern infestation here are defined as infestations occurring starting in 1962, the first infestation which was detected by the use of lure traps and that aircraft delivered controls was a major component.
[2] "Early detected" infestation here are defined as infestations where the area under quarantine is 110 square miles or less.

(b) Cost of Living with Medfly

The Policy Analysis and Development Staff (PAD), PPD, APHIS completed an economic analysis of the Medfly program in Guatemala in 1989 (Vo, 1989). As part of this project an estimation of the potential impact was calculated for Medfly if it was permanently established throughout its ecological range in the continental United States. This is the most comprehensive analysis of the potential impact for Medfly in the United States to date and is comparable with previous estimates for the United States and for California (Galt and Albertson, 1981). The total annual loss estimates was from $821 million to $831 million. Table 11 identifies six categories of loss and the percentage of the loss estimated by the 1989 study.

Table 11 - Potential U.S. Loss from Medfly Estimated Annual Costs (total) $821 million to $831 million	
Categories	Percent of Total Loss
Field loss of crops	37.0
Cost of field treatment	9.0
Cost of quarantine treatment	4.2
Loss caused by quarantine treatment	1.6
Loss of export markets	40.0
Cost of eradicating spot infestations	0.3

(c) Cost Associated with Exclusion and Detection

The FY 1990 APHIS budget gives two line item estimates that are directly associated with Medfly exclusion and detection. Agricultural quarantine inspection (budget estimate 64.6 million) is allocated for pest exclusion and other port activities. Many of these activities are not associated with Medfly exclusion (e.g., preclearance from Puerto Rico). The other fund is the Medfly budget estimate ($9.7 million). The major cost for this item is for Medfly detection and the rearing of sterile Medfly. The other major costs associated with exclusion and detection of Medfly and not presented here are the costs to the states for detection and the cost allocated by ARS for research.

(d) Comparing Cost

Table 12 gives a rough comparison between the cost of living with Medfly versus the costs of exclusion, detection, and eradication. Another comparison that should be noted is that the estimated annual cost of Medfly infestations is over 50% of the AQI budget which is used for the exclusion of all exotic plant pests and other unrelated activities.

TABLE 12 - COMPARISON COST

Annual Loss Estimate of Living with Medfly $821 to 831 million

VERSUS

Estimated Annual Infestation Cost (1.4 average annual number of infestations) X $23.6 million (average cost of modern infestation)).	$33 million
AQI Budget (Only part for Medfly) for FY 1990.	64.6 million
Medfly Budget for FY 1990.	9.7 million
Other Costs	Not determined
TOTAL (Roughly $\pm$)	**$120 million**

4. High Risk Ports

Risk is commonly defined as the likelihood (or probability) of an adverse event occurring times the magnitude (or consequence) of the event if it occurs; thus, exotic pest risk can be defined as the probability of an exotic pest becoming established times the impact of that pest on the United States if that pest becomes established. When comparing pathways or ports for the same pest (Medfly), the consequence will generally be the same. For example, the consequences are the same whether Medfly becomes established in Los Angeles, California, via mail from Hawaii or passengers baggage from Europe; and the consequences could be about the same for an infestation in southern Florida caused by a passenger carrying infested fruit through JFK and another infestation in southern California caused by a passenger entering the country at the port of Los Angeles. In conclusion, the pest risk for Medfly for various pathways, for various clearance activities and for different ports will vary based on the first component of risk, the probability of Medfly becoming established.

Given the above, then the pest risk for Medfly via a single pathway through a given port can be broken down into various factors that affect the probability of it becoming established. For air passengers this would be expressed as:

No. of passengers from Medfly country	X	Prob. of passengers having infested fruit	X	Prob. of passengers evading quarantine	X	Prob. that destination of passenger is favorable for colonization	X	Prob. of colonization at favorable location	=	Probability of Medfly becoming established via air passenger

With this model, we can compare the risk for Medfly for two flights originating in Italy (or Latin America). One is destined to Los Angeles, California, the other to JFK, New York. It could be easily assumed that on both flights all factors would be about the same except for the probability that the passenger is destined to an area favorable for colonization. We could guess that on a typical flight, about 10 percent of the passengers landing at JFK are headed for a high risk area and about 50 percent of those people landing in LA are destined to such an area. If so, the risk for the flight at LA would be five times greater than the same for JFK. This line of reasoning was used to help determine the risk of various pathways summarized in Section E of this assessment. It should also be noted that for APHIS to reduce the Medfly risk for LA to the JFK level in the example above we would have to reduce the probability of a passenger having infested fruit (by increasing public awareness) or of the probability of the passenger evading quarantine (by greater degree of inspection) to one fifth of their present levels or by a combination of the two. These would be difficult to do.

By considering such factors for each important pathway for each port, the ports can be rated as to whether or not they are high risk for Medfly thus a port would be a high risk port if several of the following types of conditions applies:

- A large number of travelers from a Medfly-infested area who are destined to a high risk area for colonization are cleared at that port.
- A significant percent of these travelers are likely to carry infested fruit.
- A significant number of U.S. domestic mail packages originating from Hawaii and destined to a high risk area is cleared at the port (this would only apply to the port of Honolulu).
- Same as above except for express package carriers.
- Large number of aircraft and/or sea craft from Medfly areas to high risk area are cleared at the port.

• A significant amount of the above are high risk carriers (e.g., small Central American boats).
• Large amounts of general cargo from Medfly areas to high risk areas are cleared at the port, and there is a significant demand for exotic Medfly host fruits in the high risk area.

Using the above criteria, Table 13 was developed. The need to designate certain ports as "high risk" was identified by the Medfly Pathway Review conducted by Gordon Tween, PPQ, and Dee Sudduth, CDFA, (Tween and Sudduth, 1989).

The above port ratings were completed for Medfly but the results for ratings based on risk for all tropical and subtropical fruit flies would be about the same except that some Mexican border port ratings would be increased. One of the major objectives of APHIS is to prevent the introduction of serious agricultural pests, not just fruit flies, into the United States and to limit the spread of others that are already established. Thus, it would not be to APHIS' advantage to use more of its resources at certain ports to reduce the introduction of fruit flies, if it might cause an equal increase of introductions of other serious pests through other ports. To determine if the high risk Medfly ports were also high risk for other agricultural pests, new pest introductions occurring between 1980 and 1989 were reviewed. Those new pests that had a significant impact were identified. They were considered to have a significant impact if:

• Federal or State government implemented an eradication program,
• Eradication program was seriously considered but not implemented because of lack of available eradication tools for the pest,
• Other significant actions taken by authorities, and/or,
• Has become a serious economic pest.

Table 13 - Medfly Risk Port Ratings

High Risk	Los Angeles, Miami, Honolulu, and possibly San Francisco
Moderatly High Risk	Other Hawaiian ports, and Tampa
Moderate Risk	Most other Florida ports, San Diego and JFK
Moderate Low Risk	Other large ports with a significant number of travelers transiting through the port to high risk areas, New Orleans, and Houston
Low Risk	All others

Table 14 - Selected List of Important New Introductions (1980 - 1989)		
Pest	Place First Detected	Most Probable Path(s) of Introduction
Melon Fly	CA	Hawaii; Predeparture
Malaysian Fruit Fly	HI	Honolulu port of entry
Medfly	CA, FL	California and Florida ports, Hawaii Predepature
Africanized Honey Bee	CA, FL	California and Florida ports
Egyptian Cottonworm	OH	New York area inspection station
Mexican Fruit Fly	CA	California ports (land, sea, or air)
Russian Wheat Aphid	TX	Natural spread from Mexico
Oriental Fruit Fly	CA	Hawaii predeparture, California ports
Black Parlatoria Scale	FL	Florida ports
White Garden Snail	CA	California sea ports
Peach fruit fly	CA	California ports
Thrips palmi	HI	Honolulu port of entry
Khapra Beetle	NY, NJ, TX	Northeastern sea ports and Texas sea ports
Citrus Canker	FL	Florida ports
Honey Bee Trachial Mite	TX	Texas border ports or natural spread
Varroa Mite	WI	Florida ports
Peanut Stripe Virus	GA	Unknown
Guava Fruit Fly	CA	California ports

A determination was then made regarding the most likely path(s) of introductions. Table 14 gives the results. The results indicate that the same ports that are high risk for Medfly (and fruit flies in general) are also high risk for other serious agricultural pests.

A. Conclusions

Based on frequency and cost of infestations (mainly eradication cost) in recent history, Medfly should be and is considered a serious threat by APHIS. The average cost of infestations to USDA and industry can be estimated at $33 million dollars a year but if not eradicated the cost to live with this pest is estimated at $821 million or more per year.

A review of past infestations clearly shows how certain areas in the United States, southern California and southern Florida have been extremely vulnerable to Medfly introductions. Current trends in travel, immigration, and port activities indicate the same areas will be just as much at risk or more so in the future. The assessment strongly suggest that certain pathways through a relatively few ports are probably responsible for the majority of the modern introductions of Medfly and other serious fruit fly pests. The highest risk pathways and ports associated with these introductions were identified as:

- Air passenger and crew baggage from foreign countries at Los Angeles, San Francisco, and Miami.
- Express mail carriers from Hawaii to California.
- Cargo ships at Florida ports from Central America.
- Cargo from foreign countries at Los Angeles, San Francisco and Miami; and from Hawaii to Californian locations.

The increasing frequency of Medfly infestations correlates closely with the increase in travel and trade. Although the resources available for the AQI program have increased, they have not increased at the same pace, thus PPQ's ability to stop the introduction of exotic pests in general has been reduced. In order to reduce the frequency of these introductions or even stop future increases in this frequency, APHIS must devote more resources to certain port activities at the high risks ports.

Additional findings of a specific nature are given in the next section with risk management recommendations.

B. Recommendations

General

(1) Designate certain ports as "high risk" ports. Los Angeles, Miami, all Hawaiian ports, San Francisco, and Tampa should be designated as high risk ports, and as such the staffing and other resources should reflect this.

(2) At "high risk" ports a small standing committee should be formed to:

- Determine what changes could occur at their work location that would decrease the probability of entry and establishment of Medfly and other high risk pests.
- Determine what information is needed to better estimate the seriousness of the various pathways at their port.
- Determine methods of gathering the above needed information.

(3) Operational Staff, PPQ should designate an operational officer with the primary responsibility of working with "high risk" ports to aid in the exchange of information, development, and implementation of new approaches concerning the exclusion of Medfly and other high risk pests.

(4) PPQ should work with ARS in the development of more effective X-ray equipment. Since PPQ depends to a large degree now and in the future probably more so on X-ray technology. APHIS needs to insure that the best is available or developed.

(5) Develop job aids or other guidelines on the effective use of X-ray for the clearance of passengers. At some locations the X-ray image is used as the sole criteria for clearance of passengers while at others they use it as "one of the tools" available to them.

(6) In Florida, California, and Texas the various PPQ work units needs to work on a continuous basis with VS to ensure that fruit with live bird shipments poses no risk to U.S. agriculture. This should include notification by VS to PPQ if shipments contain fresh fruits, and agreements of how and when the fruit is destroyed.

(7) Ports of entry in Florida, California, Texas, Hawaii and other southern locations should review their procedures concerning the possible presence of fruit with imported mammals such as apes.

(8) Consider expanding the Central American Visa Insert Program to all or most Spanish speaking countries (Spain, The Phillipines, and most Latin American countries). Most of these locations are high risk for fruit flies and other serious agricultural pests.

California and Florida

(9) Test a "mini-blitz" team concept at high risk ports for cargo. Using a team of two or three people at Los Angeles and/or Miami, inspect cargo for the presence of prohibited fruit fly material and other high risk material. The cargo inspected would be identified by the use of profiles that would be

developed by the port PPQ personnel. The profile for Miami should identify cargo from Central America, South America, and southern Europe. Cargo from the West Indies should be given less attention because of the absence of the serious exotic pests. The profile for Los Angeles should avoid concentrating on dry citrus peel because the risk from this material is relatively low.

(10) In Los Angeles and Miami and possibly San Francisco. PPQ dog teams should be used periodically over a 12-month time period to assess the risk of fruit from fruit fly infested areas moving by express carriers.

California

(11) At Los Angeles and later possibly at other high risk ports determine the feasibility of utilizing additional X-ray technology. This could include the following.

- The use of X-ray for the examination of hand baggage of air passengers. This could be set up in an area before passengers reach Immigration. This could be operated in such a matter as to X-ray as many hand bags as possible without seriously delaying passenger flow thus finding additional prohibited products and making USDA presence more obvious to the traveling public.
- The use of a large remote X-ray monitor in clear view of the air passengers as they wait for Immigration clearance with a sign stating that their baggage is subject to X-ray and if undeclared agricultural products are found that the passenger will be fined.
- The use of X-ray for the clearance of pit baggage from high risk flights before the baggage reaches the baggage claim area. Suspect baggage would be flagged for later examination.

(12) Test the use of undercover investigative teams in Los Angeles and possibly in Miami. These teams would investigate the selling of prohibited fruit fly host material at the retail level (street vendors and small ethnic stores). Again the team should avoid using their resources to find lower risk material such as citrus peel. The advantage of dealing with the retail level is that all of the commercial shipments that pose a major risk are funneled into a relatively small area. The detection at the retail level would also be independent of how and from where the shipments arrived.

Florida

(13) Consider conducting an epidemiological-type study in the Miami Springs area, either now or during any future outbreak of Medfly at this location. In this small area there has been three Medfly infestations (1962, 1963, and 1990) and a single fly catch (1983).

(14) In Miami, and other Florida ports of entry, PPQ should fine tune local profiles for cargo, ships and passengers. At present, the profiles are based largely on the amount of prohibited agricultural material and reportable pest interceptions associated with clearance activities from various countries. Since a large portion of the cargo and passengers in Miami originate from the West Indies and they produce a large amount of prohibited agricultural products and/or pest interceptions they are considered high risk. In reality, the pest risk from this locations is not high because many of these pests are already established in the United States or are minor pests. The profiles should take into consideration the more serious pests that threaten the United States from other locations. These would include Medfly, Mexican fruit flies, and citrus canker from South and Central America.

(15) The Southeast Region should determine the feasibility of development of a system where U.S. Customs would notify PPQ when yachts arrive from "high risk" areas. Most yachts arrive in Florida from the Bahamas. Because of the large number of arrivals and because of the absence of agricultural material in the large percentage of these yachts PPQ stopped boarding yachts in most Florida ports several years ago. Because of a new notification system that Customs now uses, it should be possible for Customs to notify PPQ of the the arrival of yachts from high risk areas. A one year test program would allow PPQ to determine if the risk warrants the needed resources.

Texas

(16) The PPQ South Central regional office or/and PPQ lower Rio Grande Valley ports, especially Brownsville, should conduct a local pathway study to determine risks from travelers from Central American locations. This may include working with IS to assess risk from the movement of people by train, bus, and airplane, as well as automobile. This would result in fine tuning of local agricultural profiles used by PPQ in the Lower Valley.

Hawaii

(17) Establish the use of an inspection log in Honolulu to be used by the cargo inspector to indicate the number of times and duration that pit baggage is checked for the presence of the agriculture seal. At present, this duty may not be completed on a daily basis because of workload, and management has no effective method of determining the degree of monitoring.

(18) Direct PPQ personnel to ask the "agricultural questions" during predeparture of passengers from Hawaii when time permits. The passengers are not generally asked if they have agricultural material at Honolulu and at certain other Hawaiian ports during predeparture even if the workload would permit it. Since no Custom declaration is required. PPQ is depending solely

on the X-ray at these locations. Consider the possibility of requiring an "Agricultural Declaration" (Written) of passengers leaving Hawaii for U.S. mainalnd.

(19) In Hawaii, management at each port should determine if fruit fly host plants are located on airport property at locations that would allow adult flies easy access to cargo or airplanes; or allow passengers returning to the mainland a chance to collect one more souvenir. If either of these situations exist management should work with airport authorities to eliminate this risk.

(20) PPQ should evaluate the possibility of infested fruit moving from Hawaii to the U.S. mainland with shipments of live birds. This was not assessed during this project because of an oversight.

(21) Increase the human resources available for the clearance of cargo from Honolulu to insure that boxes containing prohibited fruit are not added to a shipment after inspection, or that prohibited fruits and vegetables are not hidden under boxes of permitted cargo, and/or that prohibited materials are not mismanifested as non-agricultural material.

(22) In Honolulu, the use of a dog team or portable X-ray should be made available for the clearance of express packages moving from Hawaii to the mainland.

(23) Baggage inspection should become a high priority at the Hawaiian ports of Kona (Island of Hawaii) and Kahului (Island of Maui) during Medfly population peaks. The largest Medfly infested locations in Hawaii occur in the Kona area on the Island of Hawaii and at Kula on Maui. At Kula, the preferred hosts are peaches, figs and loquats and the infestation peak is from February to May. In Kona the peak is during the period of the year when coffee berries, the major host at this location are ripe.

(24) PPQ should trap for Medfly at the airport in Kona, Hawaii to determine the abundance of Medfly at that location. Previous trapping results by either PPQ or ARS has indicated that Medfly is absent or relatively rare at or around the other airports of concern in Hawaii. The trapping should be conducted for at least one year. Two or three traps would be sufficient to determine if a potential pathway exists for adult flies.

(25) Develop a public awareness program in Hawaii that targets cargo shippers, produce exporters, express mail carriers.

4. APPENDIXES

INFESTATION INFORMATION

MEDFLY INFESTATIONS IN THE CONTINENTAL UNITED STATES BY DECADE

	1990 - Miami, FL
1990	1988 - L.A., CA 1989 - Santa Clara, CA 1985 - Miami, FL 1987 - L.A., CA 1980 - Santa Clara, CA 1988 - L.A., CA 1984 - Miami, FL 1987 - Miami, FL 1980 - L.A., CA 1989 - L.A., CA 1981 - Tampa, FL
1980	1975 - L.A., CA
1970	1966 - Brownsvill, TX 1963 - Miami, FL 1962 - Southern FL
1960	1956 - Southern FL
1950	
1940	
1930	
1920	1929 - Central FL

Summary of Medfly Infestations in the Continental United States

1. Florida - 1929

A. Dates: Larvae of Medfly were found on April 6, 1929, and the infestation lasted until July 1930 (Weems 1981; Clark and Weems, 1988).

B. Location: Central Florida

C. Size of Infestation: The first Medfly was found in grapefruit in the vicinity of Orlando and the infestation spread into 20 counties of Florida. The treatment area was 200 square miles large and 1,002 infested properties were found (Burgess, 1964; Clark and Weems, 1988).

D. Eradication Methods: The main eradication procedure was fruit stripping with arsenic (and later copper carbonate) bait applied with ground equipment. More than 5,000 laborers and as many as 1,200 inspectors were employed. McPhail traps with kerosene as a male lure were used but fruit cutting was the major detection tool (Burgess, 1964; Jackson and Lee, 1985; Clark and Weems, 1988).

E. Cost: It cost more than $7.5 million to eradicate plus many millions more because of crop destruction or inability to ship crops to market (Steiner, *et al.* 1961; Clark, 1988). $7.5 million in year 1929 is equivalent to $56.5 million in 1990 (estimated from the Consumer Price Index).

2. Florida - 1956

Dates: Larvae were found on April 13, 1956, and the last fly was found on November 26, 1957. The final control treatment took place on February 25, 1958, and the quarantine was lifted the following day (Burgess, 1964; Clark and Weems, 1988).

B. Location: Southern and Central Florida

C. Size of Infestation: Medfly larvae were found in grapefruit from Miami Shores. The infestation spread into 28 counties over a 1,000 square miles area involved. Catches in single residential lots ranged up to 1,500 flies before the spray program began (Steiner, *et al.* 1962; Jackson and Lee, 1985).

D. Eradication Methods: The main control tool was malathion bait spray applied by air and ground equipment (Burgess, 1964). About 800 employees were engaged in the eradication (Steiner, *et al.* 1961). Steiner traps were used with oil of Angelica seed as a male lure. Later new synthetic lures called ENT 21478 and ENT 21486 were used (Clark and Weems, 1988).

E. Cost: The eradication cost was approximately $11 million. Losses by crop destruction or inability to ship crops to market was not significant (Steiner, *et al.* 1961; Clark and Weems, 1988). $11 million in 1957 is equivalent to $50.6 million in 1990 using GAP Implicit Price Deflater.

3. Florida - 1962

A. Dates: The first flies were trapped on June 8, 1962, and the last fly was captured 9 months later on February 5, 1963. The spray program continued through April 10, 1963 (Burgess, 1964). The quarantine was lifted on May 7, 1963 (Clark and Weems, 1988).

B. Location: Southern Florida

C. Size of Infestation: The first flies were trapped in the city of Miami near the Miami International Airport. The infestation spread from Dade County to Broward and Palm Beach Counties (Burgess, 1964; Clark and Weems, 1988). The spray area encompassed 722 acres large (APHIS, 1988).

D. Eradication Methods: The main eradication method was malathion bait spray from both ground and air equipment (Burgesss, 1964). The plastic Steiner trap was used with Trimedlure (Clark and Weems, 1988).

E. Cost: Eradication cost was about $1 million (Clark and Weems, 1988). $1 million in 1962 is equivalent to $4.1 million in 1990 using the GAP Implicit Price Deflater.

4. Florida - 1963

A. Dates: Medfly was first detected on June 17, 1963, and the last fly captured on August 18, 1963. The spray program concluded on October 21, 1963 (Burgess, 1964). The quarantine was lifted on November 26, 1963 (Clark and Weems, 1988).

B. Location: Miami, Florida

C. Size of Infestation: A fly was detected near the Miami International Airport and the treatment area was encompassed 726 acres (Clark, 1988; USDA, 1988).

D. Eradication Methods: Aerial application of malathion bait spray (Burgess, 1964).

E. Cost: The eradication cost is reported in difference sources at various amounts: $300,000 (Burgess, 1964), $100,000 (Clark and Weems, 1988; Poucher,

1964), and $1 million (USDA, 1988). $300,000 in 1963 is equivalent to $1.2 million in 1990 using GNP Implicit Price Deflator.

5. Texas - 1966

A. Dates: The first fly was trapped June 13, 1966, and the last fly on July 27, 1966. Spray program was in place until September 27, 1966 (Stephenson and McClung, 1966).

B. Location: Southern Texas

C. Size of Infestation: Fifty-two properties within the city limits of Brownsville were found infested with either larvae or adults. Four adults were also trapped in Matamoros, Mexico (across the river from Brownsville). A total of 238 adults (Only 20 females) and 15 properties with larval infestations were found. Larval finds occurred in calamondin, peach, and sour orange. 12,800 acres were in the treatment area including 1,300 acres in Mexico (Stephenson and McClung, 1966).

D. Eradication Methods: Aerial application of malathion without was used at first and later with bait (Stephenson and McClung, 1966).

E. Cost: $372,000 for eradication. This is equivalent to $1.4 million of 1990 using GNP Implicit Price Deflator.

6. California - 1975

A. Dates: The first fly was trapped on September 24, 1975, and the last on November 14, 1975. The last control treatments (sterile flies) took place in May. Eradication was declared on August 2, 1976 (Consortium for international Crop Protection (CICP), 1985).

B. Location: Los Angeles County, California (Venice area)

C. Size of Infestation: Twelve properties were found with larval infestations (all in peaches) and a total of 77 adults were captured (Scribner, 1983). The infestation spread out over a 28 square mile area and 35-40 people were employed in the project (Cunningham, *et al.* 1980). The treatment area covered 35 square miles and the quarantine area covered 100 square miles (CICP, 1985).

D. Eradication Methods: Sterile insect technique was used with ground spraying of host plants and fruit stripping to augment (Jackson and Lee, 1985).

E. Cost: About $1 million for eradication (Cunningham, *et al.* 1980). This is equivalent to $2.2 million in 1990 using GNP Implicit Price Deflater.

7. California/Los Angeles - 1980

A. Dates: The first Medfly were trapped on June 5, 1980, and the last trapped on June 14, 1980. The last sterile flies were released on October 18, 1980. Eradication was declared on December 18, 1980 (Rohwer, 1987; Scribner, 1983; and CICP, 1985).

B. Location: Los Angeles, California

C. Size of Infestation: The flies were found in Northridge, Los Angeles County. A total of four adults and one larval site (six larvae in loquat) were found. The treatment (sterile flies) and quarantine area encomposed 100 square miles (Scribner, 1983; Jackson and Lee, 1985; and CICP, 1985).

D. Eradication Methods: One application on July 3 of malathion bait with hand-sprayer to the three sites where flies had been caught and then the release of 260 million sterile flies (aerial, roving, and static) (Jackson and Lee, 1985; and CICP, 1985).

E. Cost: $625,000 (CICP, 1985). This is equivalent to $1 million in 1990 using the GNP Implicit Price Deflater.

8. California/Santa Clara - 1980

A. Dates: The first flies were captured on June 5, 1980, and the last on June 25, 1982. Eradication was declared on September 21, 1982 (Jackson and Lee, 1985; and Scribner, 1983).

B. Location: Northern California

C. Size of Infestation: The infestation started in Santa Clara County and spread into seven other counties including Los Angeles. The treatment area encompassed almost 1,500 square miles and at the peak, 4,000 Federal and State employees were involved. Over a 4,000 square mile area was regulated. Over 400 adults were captured plus a large number of larval sites were found (Jackson and Lee, 1985; Scribner, 1983; and Rohwer, 1987).

D. Eradication Methods: Sterile insect technique was used at first. This was later replaced by aerial malathion bait spray. Fruit stripping and ground spray were also used (Jackson and Lee, 1985).

E. Cost: Eradication cost was about $100 million. Estimates of industry loss due to export bans and commodity treatments ranged from $73.7 million to

$100 million (Jackson and Lee, 1985; Rohwer, 1987). $200 million in 1981 is equivalent to $294 million in 1990 using GNP Implicit Price Deflater.

F. Note: The part of this infestation within Los Angeles County can be considered a separate infestation. It was separated by hundreds of miles from the infestation in Northern California, but it was believed that the invasion was the result of infested hosts movement from the Santa Clara Valley (Rohwer, 1987). In Los Angeles, the first flies were found on August 25, 1981, in Baldwin Park. Forty-eight adults were captured in total and four larval sites were found (peach, guava, and Meyer lemon). The treatment area encompassed 36 square miles (CICP, 1985).

9. Florida - 1981

A. Dates: The first flies were captured on August 4, 1981, and the last on August 9, 1981. The control program ended on October 8, 1981. The quarantine was lifted on November 12, 1981 (Johnson, 1982; Clark and Weems, 1988).

B. Location: Tampa, Florida

C. Size of Infestation: A total of five adult flies captured, no larvae found and the treatment area encompassed 16 square miles. One hundred twenty employees were involved in the eradication at the peak (Johnson, 1982).

D. Eradication Methods: Aerial and ground malathion bait spray was used (Jackson, 1985). The spray was applied every seven days for a total of eight applications (Clark and Weems, 1988).

E. Cost: $1 million (Alfieri, 1984). This is equivalent to $1.4 million in 1990 using the GNP Implicit Price Deflater.

10. Florida - 1984

A. Dates: The first flies were captured on June 19, 1984, and the last fly on July 4, 1984 (Alfieri, 1984). Control treatments ended on August 28, 1984, and the quarantine was lifted on November 2, 1984 (Clark and Weems, 1988).

B. Location: Miami, Florida

C. Size of Infestation: A total of 11 adult flies were captured and one larva was found in a sour orange. The area treated was 7.5 square miles large and 81 square miles were under quarantine (Alfieri, 1984).

D. Eradication Methods: Ground and aerial applications of malathion bait spray was used (Alfieri, 1984).

E. Cost: About $1 million (USDA, 1988). This is equivalent to $1.2 million in 1990 using the GNP Implicit Price Deflater.

11. Florida - 1985

A. Date: The first flies were captured on February 25, 1985, and the last flies were captured on April 9, 1985. The control treatment (sterile flies) ended in July 1985, and the quarantine was lifted on August 27, 1985 (Clark and Weems, 1988).

B. Location: Miami, Florida

C. Size of Infestation: The first fly was trapped near the Opa Locka Airport in North Miami. The only two other flies were trapped approximately 2.25 miles southwest of the first catch. The quarantine area was 110 square miles large (Clark and Weems, 1985).

D. Eradication Methods: Four aerial applications of malathion bait spray (once a week) were used. From May 7 to July sterile flies were released over the quarantine area. 5.5 million flies per day, five days per week, with an additional 2.6 million flies released weekly from the ground in the 3.5 square mile core (Clark and Weems, 1988).

E. Cost: About $2.2 million (USDA, 1988). This is equivalent to $2.5 million in 1989 using the GNP Implicit Price Deflater.

12. Florida - 1987

A. Dates: The first flies were captured on March 2, 1987, and eradication was declared on July 17, 1987 (USDA, 1988).

B. Location: Hialeah, Florida

C. Size of Infestation: Five males were captured in one trap on March 2, 1987, and one larva was found in a calamondin fruit on March 5, 1987. The treatment area was 9 square miles large and the quarantine area was 81 square miles (USDA, 1988).

D. Eradication Methods: Ground and aerial application of malathion bait spray followed by sterile fly release (USDA, 1988).

E. Cost: About $1.3 million (USDA, 1988). This is equivalent to $1.4 million in 1990 using the GNP Implicit Price Deflater.

13. California/Los Angeles - 1987

A. Dates: The first Medfly was trapped July 27, 1987, and the last on September 3, 1987. Treatment (sterile flies) ended on November 17, and eradication was declared February 5, 1988 (USDA, 1988; Anonymous, 1988; and Penrose, 1988).

B. Location: Los Angeles, California

C. Size of Infestation: The first flies were captured in East Los Angeles (City) and later flies were taken in the City of Maywood, about 3-1/2 miles from the original fly find. The treatment areas were in a 22 square mile area around the first find and a 13-1/3 square mile around the Maywood finds. The regulated area was 110 square miles large. A total of 42 adults were captured and larvae were found on one property (Henry, 1988; Anonymous, 1988; and Penrose, 1988).

D. Eradication Methods: Ground and aerial applications of malathion bait spray (one treatment to each of the treatment areas) and release of sterile flies. In total 582 million flies were released (Anonymous, 1988; Penrose, 1988).

E. Cost: About $2 million (Anonymous, 1988). This is equivalent to $2.2 million in 1990 (GNP Implicit Price Deflater).

14. California/Los Angeles Co./Northridge area - 1988

A. Dates: The first flies were trapped on July 20, 1988, and the last on July 31, 1988. Eradication was declared on November 15, 1988 (O'Connor, 1988a).

B. Location: Los Angeles Co., California

C. Size of Infestation: A total of six adults and no larvae were found at five different sites in the Northridge area. The treatment area (malathion bait) encompassed 16 square miles (O'Connor, August 25, 1988).

D. Eradication Methods: The eradication tools included aerial spray with malathion bait (one treatment) and sterile fly release (O'Connor, 1988a).

E. Cost: $3.357 million including the 1988 West Los Angeles infestation (per. com. John Connell, CDFA). This is equivalent to $3.6 million in 1990 using the GNP Implicit Price Deflater.

15. California/West Los Angeles - 1988

A. Dates: The first Medfly was detected on September 26, 1988, and the last fly on October 6, 1988. On June 12, 1989, eradication was declared (O'Connor, 1988a).

B. Location: Los Angeles, California

C. Size of Infestation: A total of 48 (38 males, 10 females) adult flies were captured and larval infestations found on seven properties in the West Los Angeles area. The treatment area (malathion bait) was 23 square miles large and the quarantine area encompassed 76 square miles (O'Connor, 1988b).

D. Eradication Methods: One treatment with malathion bait followed with the sterile fly release (O'Connor, August 25, 1988).

E. Cost: Included in proceeding infestation.

16. California/Los Angeles - 1989

A. Dates: The first fly was trapped on July 20, 1989. The quarantine was lifted on November 9, 1990.

B. Location: Los Angeles, California

C. Size of Infestation: The first flies were trapped in Elysian Park in the city of Los Angeles. After that, various outbreaks have occurred in the counties of Los Angeles, Orange, San Bernandino, and Riverside. Over 270 adult flies were captured and 27 larval sites found. The larvae were first found in peaches, but later found in additional hosts including persimmon, strawberry guava, Meyer lemon, calamondin, orange, kumquat, and fig. The spray areas covered 547 square miles and the quarantine areas covered 1,362 square miles (Per. com. Charles Overmiller, PPQ, June 12, 1990).

D. Eradication Methods: Some areas were treated once with malathion bait followed with sterile fly release and others received multiple applications of malathion bait spray.

E. Cost: The total cost for both the Los Angeles and the Mountain View eradications was $58.6 million as of September 30, 1990.

17. California/Mountain View - 1989

A. Dates: The first fly was captured on August 31, 1989, and the last fly find was September 18, 1989 (Per. com. Charles Overmiller, PPQ, 1990). The quarantine was lifted on September 14, 1990.

B. Location: Mountain View, Santa Clara County, California

C. Size of Infestation: A total of 25 adults were trapped and two larva sites were found. The larvae were found only in peaches. The spray area was 11 square miles, the sterile release area was 47 square miles, and the quarantine area was 60 square miles large (Per. com. Charles Overmiller, PPQ, 1990).

D. Eradication Methods: One treatment of malathion bait spray followed with sterile release.

E. Cost: Included in proceeding infestation.

18. Florida - 1990

A. Dates: The first fly was trapped on April 16, 1990. The last fly was trapped on May 21, 1990. The eradication program ended on August 3, 1990 (Per. com. Charles Overmiller, PPQ, 1990).

B. Location: Miami, Florida

C. Size of Infestation: The first fly was trapped in Miami Springs about two blocks from Miami International Airport. A total of 23 adult flies were captured. The treatment area is 20 square miles and the quarantine area is 96 square miles large (Per. com. Charles Overmiller, PPQ, 1990).

D. Eradication Methods: Eight aerial applications of malathion bait spray.

E. Cost: The total eradication cost was $1.8 million.

SUMMARY OF MEDFLY DETECTIONS NOT INCLUDING INFESTATIONS

This is when one fly (#6 below--2 flies were captured) has been trapped, the trapping increased, no additional finds and no eradication program used.

1. 1964 (May 20) - Miami, Florida; this fly was taken near Pier 3 in Miami (Clark and Weems, 1988)

2. 1967 (October 10) - Miami Beach, Miami, Florida (Clark and Weems, 1988)

3. 1980 (November 28) - Mt. Helix, San Diego Co., California

4. 1982 (July 21) - Los Angeles, California; in Hancock Park (Atkins, 1987)

5. 1983 (May 31) - Miami, Florida; near Miami International Airport in Miami Springs (Clark and Weems, 1988)

6. 1984 (August 8) - Two flies trapped, Port of Miami, Dodge Island (Alfieri, 1984)

7. 1984 (August 14) - Santa Barbara, California (Henry, 1988)

8. 1984 (November 21) Beverly Hills, California (Arkins, 1987)

9. 1986 (March) - Miami, Florida (Indian Rocks Beach near Clearwater) (Pers. Com. Ms. Debra Chalot, PDI, Jan. 1990)

10. 1986 (December 4) - Los Angeles, California; in Sawtelle (Atkins,1988)

11. 1986 (August 25) - Coronado, San Diego Co., California

12. 1987 (October 13) - Westminster, Orange Co., California; approximately 20 miles from Los Angeles' 1987 infestation (Penrose, 1987)

13. 1988 (March) - Miami, Florida (Sweetwater) (Pers. com. Ms. Debra Chalot, PDI, Jan. 1990)

14. 1990 (April 24) - Fort Lauderdale, Florida (Port Everglades) (Pers. com. Charles Overmiller, PPQ, June 6, 1990)

Note: On September 8, 1987, one fly was captured in Los Angeles, California, in Rimpau. This find was outside of the 1987 Medfly infestations boundaries occurring in Los Angeles (Penrose, 1987). For the purpose of this document this is not considered a separate detection.

APPENDIX B

INTERCEPTION INFORMATION

TABLE 1 - INTERCEPTIONS OF MEDFLY BY YEAR FROM VARIOUS REGIONS

(Calendar Year)

Region	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	Total [2]
Hawaii	143	30	37	46	35	23	24	28	9	11	18	16	27	21	7	11	3	489
Central America	1	2	3	3	2	6	3	5	5	3	4	6	10		1		3	57
South America	9	3	5	7	5	6	7	8	10	5	6	9	5	3	2	1	1	92
Mediterranean Area	39	6	23	47	36	56	51	37	47	42	36	72	47	54	75	39	45	752
Sub-Sahara Africa[1]	17	14	31	26	22	13	8	3	8	3	4	4	4	11	5	2		175

[1]Interceptions from Sub-Sahara Africa were identified as Ceratitis sp. or Ceratitis capitata.
[2]Ninety-seven interception records occurring during this time period were not used in the above table because origin was given as unknown, questioned by the Officer or questioned by the assessor.

TABLE 2 - INTERCEPTIONS OF MEDFLY BY COUNTRY AND WHERE INTERCEPTED (FY 1980 - 1987)

ORIGIN	PASSENGER BAGGAGE	MAIL	ON AIRLINE OR SHIP (NO ENTRY)
NEW WORLD			
A. Hawaii (subtotal)	118		
B. Central America (subtotal)	22		2
-Costa Rica	7		
-El Salvador	9		
-Guatemala	4		1
-Honduras	1		
-Panama	1		1
C. South America (subtotal)	27		10
-Argentina	3		1
-Bolivia	2		
-Brazil	4		6
-Colombia	1		
-Ecuador	5		
-Peru	10		1
-Venezuela	2		2
OLD WORLD			
D. Mediterranean area (subtotal)	373	3	12
-Azores	14		
-Cyprus	7		
-Egypt	11		
-Greece	37		3
-Israel	41	1	
-Italy	144	2	
-Jordan	10		
-Lebanon	8		
-Portugal	83		4
-Spain	3		4
-Other	15		1
E. Sub-Sahara Africa (subtotal)	20		
-Ghana	5		
-Liberia	4		
-Nigeria	7		
-Sierra Leone	3		
-Zambia	1		
TOTALS	**560**	**3**	**24**

TABLE 3 - INTERCEPTIONS OF MEDFLY BY HOST AND MOST COMMON ORIGIN

HOST	NO. OF INTERCEPTIONS 1971-1987 [1] (Calendar Year)	MOST INTERCEPTIONS WERE FROM: (IN DESCENDING ORDER OF FREQUENCY)
Capsicum spp. [2]	189	West Africa
Citrus spp.	115	Mediterranean area
Coffea arabica	285	Hawaii, and to a lesser degree, Central and South America
Cydonia oblonga	43	Italy
Diospyros spp.	14	Europe
Eriobotrya japonica	20	Italy, Greece, Israel, Portugel
Ficus carica	234	Central & South America, Egypt, Hawaii
Malus sylvestris	32	Portugal, Italy
Mangifera indica	70	Central & South America, Egypt, Hawaii
Opuntia spp.	35	Italy
Passiflora spp.	13	Hawaii (all)
Prunus armeniaca	14	Italy, Greece, Israel
Prunus persica	74	Italy, Portugal, Brazil
Prunus quajava	174	Mediterranean area, Hawaii
punica granatum	24	Mediterranean area
Pyrus communis	34	Italy, Portugal, Greece
Syzygium spp.	21	Hawaii
Terminalia catappa	94	Hawaii
Vitis spp.	10	Mediterranean area
All others	167	
TOTAL	1662	

[1] All hosts are listed with 10 or more interceptions.
[2] The 189 interceptions from Capsicum from West Africa were identified as Ceratitis sp. or Ceratitis capitata.

TABLE 4 - INTERCEPTED FRUIT FLIES FROM HAWAII (1970-1987)

DETERMINATION	NO. OF INTERCEPTIONS
Ceratitis sp.	1
Ceratitis capita	705
Dacus sp.	141
Dacus cucurbitae	151
Dacus dorsalis	6604
Dacus latifrons	1
Species of Tephritidae	342
TOTAL	

TABLE 5 - INTERCEPTION OF MEDFLY FROM HAWAII 20 [illegible]

HOSTS	70[1]	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87[1]	TOTAL
Annona cherimola (Cherimoya)		1	1																2
Calophyllum inophylum				2	1	1	1		1			1							7
Carica papaya (Papaya)		1		1		1	1												4
Citrus aurantifolia		1																	1
C. grandis					1														1
C. paradisi (Grapefruit)							1												1
C. reticulata	1	1									1								3
C. sinensis														1					1
C. sp.				1	1														2
Coffea arabica (Arabian coffee)[2]	198	120	28	25	24	16	12	11	7	2	3	4	7	3		1	7		468
Eriobotry japonica (Loquat)							1			1									2
Eugenia sp.											2								2
Ficus benghalesis	1																		1
Fruit (Unidentified)					2	5	1										1		8
Litchi chinensis (Litchi)	1								1										2
Mangifera indica (Mango)	1	2			1	3	1	1	2					1					12
Murraya sp. (Mock orange)		1																	1
Pandanus odoratissimus (Plant)					4														4
Passiflora edulis (Passion flower)	1	3			1	1	1		1		1	2	1	1	1				14
Persea american (Avacado)	1	2					1			1				2		1			8
Prunus persica (Peach)	2																		2
Psidium guajava (Guava)	7	5	1	1	4	3	2	1	3	1	1	4	1	5	2	3		3	47
Punica granatum (Pomegranate)		1						1											2
Syzgium jambos (Rose apple)								1					2						3
S. malaccense (Mayay apple)	3	1			2	2	1		2	2		1	3		1				18
Terminalia cat		4		7	5	3		9	11	2	3	6	2	16	15	3	3		89
Totals	216	143	30	37	46	35	23	24	28	9	11	18	16	27	21	7	11	3	705

[1]The database was not complete for 1970, and all 1987 interception records were not entered into the database on the query date (January 9, 1989); thus, there may have been additional interceptions for those years.

[2]From the late 1960's to the early 1970's, Civil Aeronautics Board regulations encouraged tourists returning from Hawaii to depart from the airport in Hilo. Because of this, large numbers of tourists would visit coffee plantations in Kona near Hilo. This explains the large number of interceptions from coffee in the early 1970's and the subsequent decrease in these interceptions (Table 1).

[3]This information is confirmed in part by interception records. All of the interception records (298) for 1970 and 1971, which indicated the port of departure, were from Hilo.

TABLE 6 - INTERCEPTIONS OF MEDFLY FROM HAWAII BY MONTH (1970 - 1987)

HOSTS	J	F	M	A	M	J	J	A	S	O	N	D	SUM
Annona cherimola (Cherimoya)	1										1		2
Calophyllum inophylum						1		1	2	1	1	1	7
Carica papaya (Papaya)				1				3					4
Citrus aurantifolia										1			1
C. grandis										1			1
C. paradisi (grapefruit)												1	1
C. reticulata										1		1	3
C. sinensis		1											1
C. sp.													2
Coffee arabica (Arabian coffee)	40	44	22	4	7	10	28	56	60	74	78	45	468
Eriobotrya japonica (Loquat)				1	1								2
Eugenia sp.										2			2
Ficus benghalesis										1			1
Fruit (Unidentified)			1			2	1	3			1		8
Litchi chinensis (Litchi)						2							2
Mangifera indica (Mango)	1		1	1	1	4	1	2			1		12
Murraya sp. (Mock orange)							1						1
Pandanus odoratissimus (Plant)									4				4
Passiflora edulis (Passion flower)	2						1	4	2	3		2	14
Persea americana (Avocado)				2		2		3			1		8
Prunus persica (Peach)						2							2
Psidium guajava (Guava)			4	1		4	3	15	8	7	3	2	47
Punica granatum (pomegranate)				1							1		2
Syzygium jambos (Rose apple)							1	2					3
S. malaccense (Mayay apple)		1		1	3	4	7	2					18
Terminalia sp. (Tropical almond)	2	3	3	4		10	9	14	12	11	7	14	89
TOTALS	46	49	31	16	12	41	52	106	88	103	94	67	705

TABLE 7 - PASSENGER BAGGAGE INTERCEPTIONS OF MEDFLY FROM HAWAII BY HOST AND AIRPORT OF DEPARTURE (FY 1980-1987)

Hosts	Hilo	Honolulu	Kahului	Kona	Lihue	Wailuku	Total
Calophyllum inophylum		1					1
Citrus reticulata		1					1
Coffea arabica (Arabian coffee)	5	11	2	6			24
Eugenia sp.		2					2
Mangifera indica (Mango)		1					1
Passiflora edulis (Passion flower)		4	2				6
Persea americana (Avacado)		3					3
Psidium guajava (Guava)	1	11	3		2	2	19
Syzygium jambos (Rose apple)		1	1				2
S. malaccense (Mayay apple)		4					4
Terminalia sp. (Tropical almond)		29	10		3		42
Totals	6	68	18	6	5	2	105

TABLE 8 - SUMMARY OF FRUIT FLY INTERCEPTIONS BY PPQ (FY 1980 - 1987) AT THE PORTS OF LOS ANGELES AND SAN DIEGO

ANASTREPHA SPP. INTERCEPTIONS						
	Los Angeles				San Diego	
ACTIVITY	Mex	Cen Am	So Am	W.I.	Mex	Cen Am
Airport baggage	219	1955	42	15		
Other airport & inspection station	5	26	6			
Mail		3				
Seaport	1		2	1	3	
Border port (baggage & mandado)					971	5

MEDFLY INTERCEPTION					
	Los Angeles				San Diego
ACTIVITY	Mex	Cen Am	So Am	Old World	Cen Am
Airport baggage	2	12	7	8	
Mail	1				
Ship stores					1

DACUS SPP. INTERCEPTIONS				
	Los Angeles		San Diego	
ACTIVITY	Hawaii	All Other	Hawaii	All Other
Aiport baggage		451		
Other airport & inspection station		7		
Mail		1		
Ship stores			2	1

TABLE 9 - INTERCEPTION OF MEDFLY IN PASSENGER BAGGAGE DESTINED TO HIGH RISK STATES (FY 1980 - 1987)

REGION	CA	FL	LA	TX	TOTAL	TOTAL %
Hawaii	98			9	107	57%
Central America	8	8	5		21	11%
South America	5	12	1		18	10%
Mediterranean Area	28	6		4	38	21%
Sub-Sahara Africa	1			1	2	1%
TOTALS BY STATE	140	26	6	14	186	

EXPERT MEETINGS DATA

Meeting Participants

1. San Diego, June 1, 1989, Subject - Medfly Pathways

Gordon Tween	APHIS, PPQ, San Diego, CA
Charles Miller	APHIS, PPD, Hyattsville, MD
Dee Sudduth	CDFA, San Diego, CA
Ed Gray	San Diego, CA
Bill Routhier	CDFA, San Diego, CA
Alejandro Perera	APHIS, IS, Hermosillo, MX
Arturo Lopez	APHIS, IS, Tijuana, MX

2. Los Angeles, June 7, 1989, Subject - Medfly Pathways

Charles Miller	APHIS, PPD, Hyattsville, MD
Dee Sudduth	CDFA, San Diego, CA
James Smith	APHIS, PPQ, Los Angeles, CA
Dorthea Zadig	CDFA, Van Nuys, CA
John Ellis	Orange Co., CA
Steve Hill	Orange Co., CA
Bob Atkin	Los Angeles Co., CA
Jim Wiseman	Los Angeles Co., CA
David Buettner	Ventura Co., CA
Eldon Reeves	Riverside Co., CA
Mark Quiseberry	Riverside Co., CA
Don Schreiber	San Bernadino Co., CA^A

3. Los Angeles, June 8, 1989, Subject - Domestic Mail

Charles Miller	APHIS, PPD, Hyattsville, MD
Patrick Fox	APHIS, PPQ, Los Angeles, CA
Sally Piper	Santa Barbara Co.,
Dennis Vinopal	Los Angeles Co., CA
John Ellis	Orange Co., CA
Lorenzo Fernandez	Orange Co., CA
Mark Quisenberry	Riverside Co., CA
Don Schreiber	San Bernandino Co., CA

4. Miami, January 26, 1990 - Medfly pathways

Bill Manning	APHIS, PPQ, Miami, FL
Lynn Oglesby	APHIS, PPQ, Miami, FL
Jorge E. Pena	University of Florida, Homestead, FL
Debra Chalot	DPI, Miami, FL
George Gwin	DPI, Miami, FL
David Storch	DPI, Miami, FL
J.A. Bruff	APHIS, PPQ, Miami, FL
Michael Hornyak	APHIS, PPQ, Miami, FL
Ralph Cooley	APHIS, PPQ, Ft. Lauderdale, FL
Richard Baranowski	University of Florida, Homestead, FL
Don von Windeguth	ARS, Miami, FL
Victor Withee	APHIS, PPQ, Miami, FL
Charles Miller	APHIS, PPD, Hyattsville, MD

5. Tampa, February 1, 1990 - Medfly pathways

Pat Henderson	DPI, Apopka, FL
Ralph Muekeley	DPI, Clearwater, FL
D.P. Hertel	APHIS, PPQ, Tampa, FL
R.L. White	APHIS, PPQ, Tampa, FL
George Forcht	APHIS, PPQ, Tampa, FL
Charles Miller	APHIS, PPD, Hyattsville, MD

6. Honolulu, April 25, 1990 - Medfly pathways

Dean Gardner	APHIS, PPQ, Honolulu, HI
Edward Shiroma	APHIS, PPQ, Honolulu, HI
Larry Nakahara	Government of Hawaii, Honolulu, HI
Guy Anzai	APHIS, PPQ, Honolulu, HI
Alan Tamiya	APHIS, PPQ, Honolulu, HI
Glenn Kobayashi	APHIS, PPQ, Honolulu, HI
Ken Ching	APHIS, PPQ, Honolulu, HI
Gordon Daida	APHIS, PPQ, Honolulu, HI
Charles Miller	APHIS, PPD, Hyattsville, MD

Summary of Questionnaire on Medfly Pathway

1. Risk to the San Diego area rated by participants of the June 1, 1989, meeting (Two questionnaires used)

Pathway	in Ratings	Rated Sources
•Cargo ship stores and quarters	Low to high	Various
•Passenger ship stores	Low to moderate	Hawaii
•Passenger ship baggage	Low to high	Hawaii
•Private ship stores/quarters	Low to moderate	Various
•U.S. Military ships	Low	Various
•Non-U.S. Military ships	Low to high	Various
•Commercial passenger planes - baggage	Low to moderate	Hawaii
•Military planes - baggage	Low to moderate	Various
•Private planes - baggage	Low to moderate	Various
•Permitted fruits-such as marginal hosts	Low to moderate	Hawaii
•Prohibited fruits - smuggled	Low to high	Central America
•Mail (domestic)	High[1]	Hawaii
•Mail (foreign)	High	Various
•Express Carriers (domestic and foreign)	High[2]	Various

•Cargo from 3rd country via Canada	Low to moderate	Various
•Cargo from 3rd country via Mexico	Low	Central America
•Baggage lots bought in Canadian stores	Low to moderate	Various
•Baggage lots bought in Mexico	Moderate	Central America
•Passengers from 3rd country via Canada	Moderate	Various
•With passenger/ car/truck from 3rd country via Mexico	Moderate to high	Central America
•From undetected Mexican infestation	Moderate	Mexico
•All other Pathways	Low	Various

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[1]One participant indicated that domestic mail from Hawaii was the highest risk pathway for the San Diego area.
[2]One participant estimated that 50 percent of the fruit is missed in exclusion activities for this pathway.

2. Risk to Los Angeles area was rated by participants of the June 7, 1989, meeting (11 questionnaires used)

Pathway	Most Common Rating	Highest Rated Source
•Commercial plane-passenger baggage[1]	High	Various
•Military plant-crew baggage	Moderate	Not indicated
•Prohibited cargo (smuggled)[2]	High	Central America
•Mail (domestic)[3]	High	Hawaii
•Mail (foreign)[4]	High	Central America
•Cargo from 3rd country via Mexico	Moderate	Central America
•Passengers from 3rd country via Mexico including illegal aliens	Moderate	Central America
•In car/truck from 3rd country via Mexico	Moderate	Central America
•From undetected Mexican infestation	Moderate	Mexico
•All other pathways	Low	Various

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[1]The participants' estimates of fruits missed in baggage ranged from 20 to 80 percent (average 45 percent). The PPQ and State participants had higher estimates than country participants. Two participants indicated that this was the highest risk pathway for the Los Angeles area.

[2]One participant indicated that this was the highest risk pathway for the area.

[3]The participants' estimates of fruits missed in domestic mail ranged from 50 percent to 90 percent (average 70 percent). Three participants indicated that this was the highest risk pathway for the Los Angeles area.

[4]The participants' estimates of fruits missed in foreign mail ranged from 20 to 75 percent (average 35 percent)

[5]Four or five of the participants rated the following pathway at moderate or high risk (the majority rated them low): baggage from passenger ship, private ships, crew baggage on passenger planes, crew baggage or stores on commercial planes, passenger baggage on military planes, permitted fruits (cargo), treated fruits (cargo), domestic express carriers, cargo via Canada from third country, baggage shipments bought in Canadian stores, passengers via Canada from third country, and baggage shipments bought in Mexico.

Sample Questionnaire

Name _____ APHIS/STATE/COUNTY/ARS _____

	Rating	Stage	Source
1. Ships (other than cargo)			
a. Cargo Ship			
Stores	____	____	____
Quarters	____	____	____
Holds	____	____	____
Garbage	____	____	____
Baggage	____	____	____
b. Passenger Ship			
Stores	____	____	____
Quarters	____	____	____
Holds	____	____	____
Garbage	____	____	____
Baggage	____	____	____
c. Private Ship			
Stores/Quarters	____	____	____
d. Military (U.S.) Ship			
Stores	____	____	____
Quarters	____	____	____
Other	____	____	____
e. Military (non-U.S.) Ship			
Stores	____	____	____
Quarters	____	____	____
Other	____	____	____

2. Airport (other than cargo)

a. Commercial Passenger Planes

Baggage -0 Passenger (% missed__)	____	____	____
Baggage - Crew	____	____	____
Stores	____	____	____
Quarters	____	____	____
Holds	____	____	____

b. Commercial Cargo Planes

Crew Baggage, Stores, Quarters	____	____	____
Holds	____	____	
(U.S.)			
Passenger Baggage	____	____	____
Crew Baggage	____	____	____
Stores	____	____	____
Quarters	____	____	____
Holds	____	____	____

d. Private Plane

Baggage	____	____	____
Stores/Quarters/Holds	____	____	____

3. Cargo

Permitted fruits (such as "marginal hosts")	____	____	____
Prohibited fruits (smuggled)	____	____	____
Treated flowers	____	____	____
Cut flowers	____	____	____
Dried fruit	____	____	____
Container 20 ft. - 40 ft.	____	____	____
Container - aircraft cargo	____	____	____

4. Mail

Domestic (HA) fruit (% missed__)	____	____	____
Foreign fruit (% missed__)	____	____	____
Other than fruit	____	____	____

5. Express Carriers

Domestic (HA) fruit (% missed __)	____	____	____
Foreign fruit (% missed __)	____	____	____
Other than fruit	____	____	____

2. Airport (other than cargo)

a. Commercial Passenger Planes

Baggage -0 Passenger (% missed__)	____	____	____
Baggage - Crew	____	____	____
Stores	____	____	____
Quarters	____	____	____
Holds	____	____	____

b. Commercial Cargo Planes

Crew Baggage, Stores, Quarters	____	____	____
Holds	____	____	
(U.S.)			
Passenger Baggage	____	____	____
Crew Baggage	____	____	____
Stores	____	____	____
Quarters	____	____	____
Holds	____	____	____

d. Private Plane

Baggage	____	____	____
Stores/Quarters/Holds	____	____	____

3. Cargo

Permitted fruits (such as "marginal hosts")	____	____	____
Prohibited fruits (smuggled)	____	____	____
Treated flowers	____	____	____
Cut flowers	____	____	____
Dried fruit	____	____	____
Container 20 ft. - 40 ft.	____	____	____
Container - aircraft cargo	____	____	____

4. Mail

Domestic (HA) fruit (% missed__)	____	____	____
Foreign fruit (% missed__)	____	____	____
Other than fruit	____	____	____

5. Express Carriers

Domestic (HA) fruit (% missed __)	____	____	____
Foreign fruit (% missed __)	____	____	____
Other than fruit	____	____	____

6. Live Plant Pest Shipments ____ ____ ____

7. Canada

Cargo from Third Country ____ ____ ____
Baggage shipments bought in Canadian stores ____ ____ ____
Passengers from Third Country ____ ____ ____

8. Mexico

Cargo from Third Country ____ ____ ____
Baggage shipments bought in Mexico ____ ____ ____
Passengers from Third Country ____ ____ ____
In car/truck from Third Country ____ ____ ____
From undetected Mexico infestation ____ ____ ____

0 = N/A
1 = Very low (most likely has not been pathway of Medfly infestations in U.S.)
2 = Low (most likely hs not been pathway of Medfly infestation in U.S.)
3 = Moderate (may have been pathway for 1 or 2 Medfly infestations in U.S.)
4 = High (probably pathway for 1 or 2 California or Florida infestations)
5 = Very High (probably pathway for 2 - 4 California or Florida infestations)
6 = Highest (most important for California - use this one only once)
[number with question mark if you are not sure. "3?"]

Source

HA = Hawaii
CA = Central America
SA = South America
Med = Mediterranean area
AF = Subsahara Africa
VC = Via Canada
VM = Via Mexico

Stage

L = Larva
P = Pupa
A = Adult

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